GOVERNMENT OF INDIA
MINISTRY OF POWER

National Energy Data: Survey and Analysis

Year 2021-22

Bureau of Energy Efficiency

Imprint

Study by

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आर. के. सिंह
R. K. SINGH

सत्यमेव जयते

विद्युत मंत्री एवं
नवीन और नवीकरणीय ऊर्जा मंत्री
भारत सरकार
Minister of Power and
Minister of New & Renewable Energy
Government of India

MESSAGE

Energy plays a vital role in economic growth, infrastructure development, and overall progress of the Nation. Access to reliable and affordable energy is crucial for powering industries, businesses, and manufacturing sectors, enabling increased production and efficiency, building critical infrastructure, including transportation networks, communication systems, and healthcare facilities.

In a growing economy like India, the best of possible use of Energy is essential to ensure that every citizen gets access to affordable energy in his daily life. Therefore, the Government policies always seek to facilitate energy availability in all the economic sectors. It becomes very important to know about the exact figures and data about energy, from the supply side and consumption side, fuel-wise and sector wise, in order to fulfil the Climate Goals about reducing emissions through systemic energy transition. Energy data enables monitoring and evaluation of energy-related initiatives and helps to identify areas for improvement.

I would like to congratulate Bureau of Energy Efficiency and the EDMU (Energy Data Management unit) team for their hard work in preparing this first report on India's Energy Sector Data. I believe that the impact of this initiative will continue helping the Nation in meeting its ambitious Energy and Climate targets.

(R.K. Singh)

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सत्यमेव जयते

आज़ादी का अमृत महोत्सव

केंद्रीय राज्य मंत्री,
भारी उद्योग और विद्युत मंत्रालय
भारत सरकार, नई दिल्ली
UNION MINISTER OF STATE FOR
HEAVY INDUSTRIES AND POWER
GOVERNMENT OF INDIA, NEW DELHI

संदेश

ऊर्जा डेटा प्रबंधन इकाई के प्रथम प्रकाशन, 'नेशनल एनर्जी डेटा: सर्वे एण्ड एनालिसिस' पर कुछ शब्द लिखते हुए मुझे खुशी हो रही है।

देश के सामाजिक-आर्थिक विकास में ऊर्जा एक महत्वपूर्ण घटक है। यह विशेष रूप से भारत के संदर्भ में सत्य है जो दुनिया की सबसे तेजी से विकसित होती अर्थव्यवस्थाओं में से एक है।

जब से भारत ने 5 ट्रिलियन डॉलर की अर्थव्यवस्था बनने की यात्रा शुरू की है, हमारी जलवायु प्रतिबद्धता को भी अद्यतन किया गया है। हाल ही में सीओपी 26 में, भारत ने अपने सकल घरेलू उत्पाद की उत्सर्जन तीव्रता को 2005 के स्तर से 2030 तक 45% तक कम करने के लिए अपने एनडीसी लक्ष्यों को अद्यतन किया, इसके साथ ही गैर-जीवाश्म ईंधन-आधारित स्रोतों से बिजली की स्थापित क्षमता का 50% और वर्ष 2070 तक शुद्ध शून्य कार्बन उत्सर्जन का लक्ष्य रखा है।

ऊर्जा क्षेत्र भारत के कार्बन उत्सर्जन का एक बड़ा हिस्सा है। इस संबंध में, बीईई ने ऊर्जा तीव्रता को ट्रैक करने के लिए ऊर्जा सुरक्षा, इसकी पहुंच और पारगमन के लिए कई नीतियां आरंभ की हैं। जैसा कि माना गया है, "यदि आप जिसे माप नहीं सकते, तो आप उसे प्रबंधित नहीं कर सकते।" ऊर्जा दक्षता ब्यूरो का यह प्रयास भारत के महत्वपूर्ण ऊर्जा के उत्पादन और उपभोग डेटा को एक प्रकाशन में लाने पर केंद्रित है। यह एक व्यापक दस्तावेज है जिसमें भारत में ऊर्जा क्षेत्र के संबंध में अद्यतन और सर्वाधिक विश्वसनीय आंकड़े प्रदर्शित हैं।

मुझे पूरा विश्वास है कि यह प्रकाशन नीति निर्धारण के लिए बहुत मददगार साबित होगा। मैं विद्युत मंत्रालय के अधिकारियों, विशेष रूप से ऊर्जा दक्षता ब्यूरो के कर्मचारियों की कड़ी मेहनत और प्रयासों की सराहना करता हूं।

जय हिन्द!

(श्री कृष्ण पाल गुर्जर)

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सत्यमेव जयते

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PREFACE

Efficient and sustainable energy supply forms the backbone of any country's economic development. India has announced one of the world's most ambitious commitments of reducing carbon intensity of its economy by 45 % by 2030 from its 2005 levels and also pledged to install 50% power capacity from non-fossil energy resources.

Availability of robust, granular and updated energy data is essential for developing and implementing appropriate policies as outcomes can be tracked in more effective manner. Considering this, the Government decided to set up an Energy Management Data Unit (EDMU) under the Ministry of Power. Set up in Bureau of Energy efficiency (BEE), it would periodically track the energy supply and consumption data across various sectors in India. The first report released in June, 2023 from this newly created EDMU is titled "National Energy Data: Survey and Analysis."

This report has presented fuel-wise supply and consumption data across various sectors of economy upto period FY 22. Use of appropriate energy equivalent conversion factors have been able to capture various energy types that are reflective of the current energy use profile of the economy. The report has been able to bring valuable insights that would assist policy makers to fine tune future policies in more realistic way, and can accelerate actions towards India's achievement of NDC. Further, the report can help in identifying the future opportunities for making the energy data compilation and reporting more comprehensive through various kind of surveys and analysis.

This first publication from EDMU is a collaborative efforts of key Ministries, NITI Aayog, other organizations and experts, which helped to bring in valuable experience for such reporting framework.

I congratulate the entire EDMU team for their hard work. I invite the energy sector professionals to review this publication and offer feedback so as to improve the future reports.

New Delhi

Dated 16.06.2023

(Alok Kumar)

RIGHT TO INFORMATION

G20 भारत 2023 INDIA

स्वच्छ भारत
एक कदम स्वच्छता की ओर

Acknowledgement

Reliable and comprehensive energy data is required to track country's progress towards its energy transition goals. In order to promote greater consistency, quality and comparability of energy data across sectors, a dedicated Energy Data Management Unit (EDMU) has been established at Bureau of Energy Efficiency (BEE) in accordance with the directions of Ministry of Power.

With the combined efforts of Bureau of Energy Efficiency and various Line Ministries/Departments to strengthen the availability of granular energy demand (consumption) and supply, I am happy to announce the launch of first EDMU report titled "National Energy Data: Survey and Analysis".

This publication has been possible under the constant guidance of Shri Alok Kumar, Secretary and Shri Ajay Tewari, Additional Secretary, Ministry of Power. The valuable contribution from EC Division (Shri Narendra Kumar, Shri Anoop Singh Bisht, Shri Govind Kumar) has been crucial in framing this report. This endeavor would not have been possible without the support of NITI Aayog Team comprising of Shri Rajnath Ram, Shri Manoj Kumar Upadhyay, Shri Venugopal Mothkoor, Shri Swapnil Morande for providing their continuous support for data collection, providing direction to the report through valuable suggestions.

Further, I appreciate the feedback from various Line Ministries/ Departments including MoSPI (Shri Indradeep Roy Chowdhury), CEA (Shri Irfan Ahmad), MoPNG (Shri Shyam Lal, Shri Amit Duhan, Shri Ramit Kalia), PPAC (Shri Vijay Kansal, Dr. Pankaj Sharma, Ms. Avantika Garg Tayal), Ministry of Coal (Shri Ankit Kumar Jain), Department of Commerce (Shri Yashvir Singh, Shri Shobeendra Akkayi), DPIIT, MNRE (Shri Arun Kumar), MOHUA, DGCA, MoRTH (Shri Mahesh Shingade), MoSPW, MoEFCC (Shri Anshu Singh).

I like to extend my appreciation to Shri Arijit Sengupta for supervising the assignment throughout the execution phase and the hard work by EDMU team (Ms. Deepshikha Wadhwa, Mr. Abhishek Kumar Yadav, Ms. Anju R Singh, Ms. Payal Kumari, Mr. Rakesh Biswas, Mr. Manish Kumar) and TERI Team (Mr. Souvik Bhattacharjya, Dr. Vatsala Sharma, Ms. Khyati Singh) for their valuable support in preparing the report by coordinating with various ministries and government agencies.

Abhay Bakre
Director General
Bureau of Energy Efficiency

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Abbreviations

AAY	Antyodaya Anna Yojana
ATF	Aviation Turbine Fuel
BLY	Bachat Lamp Yojana
CBDR-RC	Common but Differentiated Responsibility and Respective Capabilities
CBG	Compressed Biogas
CCS	Carbon Capture and Sequestration
CEA	Central Electricity Authority
CIL	Coal India Limited
CoP	Conference of the Parties
ECSBC	Energy Conservation and Sustainable Building Code
EESL	Energy Efficiency Services Limited
EoUs	Export Oriented Units
GCF	Green Climate Fund
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GOBAR-DHAN	Galvanizing Organic Bio-Agro Resources Dhan
GTL	Gas to Liquid
GW	Gigawatt
HSD	High-Speed Diesel
IBEF	Indian Brand Equity Foundation
IOCL	Indian Oil Corporation Limited
IRES	International Recommendation for Energy Statistics
ISIC	International Standard Industrial Classification of All Economic Activities
MMSCMD	Million Metric Standard Cubic Meters Per Day
MMT	Million Metric Tonnes
MMTPA	Million Metric Tonnes per Annum
MT	Million Tonnes
MW	Megawatt
NDC	Nationally Determined Contribution
NEP	National Electricity Plan
NIC	National Industrial Classification

ONGC	Oil and Natural Gas Corporation
OPC	Ordinary Portland Cement
PAT	Perform, Achieve & Trade
PBFSC	Portland Blast Furnace Slag Cement
PMAY	Pradhan Mantri Awas Yojana
PMUY	Pradhan Mantri Ujjwala Yojana
PNGRB	Petroleum and Natural Gas Regulatory Board
PPC	Portland Pozzolana Cement
SATAT	Sustainable Alternative Towards Affordable Transportation
SAUBHAGYA	Sahaj Bijli Har Ghar Yojana
SCCL	Singareni Collieries Company Limited
SDG	Sustainable Development Goals
SEC	Specific Energy Consumption
SEEP	Super-Efficient Equipment Programme
SEZ	Special Economic Zones
TMT	Thousand Metric Tonnes
UJALA	Unnat Jyoti by Affordable LEDs for All
UNCED	United Nations Conference on Environment and Development
UNFCCC	United Nations Framework Convention on Climate Change

Executive Summary

Climate change is one of the most challenging phenomenon being faced by the humanity and India has been at the forefront of addressing this issue. India ratified the Paris Agreement in 2016 under which its member countries have given commitments to keep the global average temperature rise between 1.5-2 degree C by the mid of this century.

India in its updated Nationally Determined Contributions (NDCs) has committed that it will reduce the emission intensity of its GDP by 45% by 2030 from 2005 level. Further, it has proposed to install 50% of the power capacity from non-fossil energy sources and aim to achieve net zero emissions by 2070.

With a population of 1.4 billion, India has a massive demand for energy to fuel its rapidly growing economy. From a power deficit nation at the time of Independence, the efforts to make India energy-independent have continued for over many decades. Industrial investments in clean energy sources and enhancing energy efficiency are hailed as two of the most viable options for any country's decarbonisation efforts, at any level of development. Today, India is a power surplus nation with a total installed capacity of over 400 GW. Keeping in mind the sustainable development goals, India's power generation mix is rapidly shifting towards renewable energy. India is the world's third largest producer of renewable energy, with over 40% of its installed electricity capacity coming from non-fossil fuel sources.

Given the importance of energy access, energy security and energy transition at the global and national level, a robust, consistent and reliable energy data can help understand the energy profile of a country. It also helps in assessing the impact of various policies and programmes. In contemporary times where energy transition holds high priority, robust energy data can help policy makers formulate data backed policies which would support countries to achieve its environmental and developmental commitment in the coming years.

With these objectives, the Government of India decided to set up a dedicated Energy Data Management Unit (EDMU) in Bureau of Energy Efficiency, under the aegis of Ministry of Power which will be discharging aforementioned functions of compiling and publishing credible data regarding the supply and consumption of energy across sectors.

The work carried out under the EDMU is a collaborative effort of different line Ministries/Departments, Think Tanks, NITI Aayog, and other stakeholders. To guide and oversee the activities of EDMU, a steering committee was formed under the chairmanship of Secretary (Power). Till April, 2023, six meetings of the Steering Committee were held to finalize the work carried out under EDMU along with the concerned ministries and departments.

It resulted in the finalization of a comprehensive report named 'National Energy Data: Survey and Analysis' for last six years i.e. from FY 2016-17 to FY 2021-22 where detailed energy supply and consumption data across sectors have been compiled and presented. It provides detailed fuel-wise energy consumption data for various sectors. This has also enabled a better understanding of the energy profile of various sectors, subsectors and consumption pattern.

This first edition of report highlights the benefit of using distinct conversion factors (of domestic coal and imported coal) for the respective years based on different calorific values of coal based on energy supply thereby giving a realistic picture of coal supply and consumption ithe country.

In the latest edition of 2023 MoSPI Report, the similar method is adopted whereby the conversion factors of coal have been derived using a weighted average methodology rather than using a single representative GCV for all grades of coal. The aforementioned revision resulted in (i) a decrease in energy supply by 18% from earlier approach in the year 2021-22 (ii) lower energy consumption value by 8% in 2021-22 (iii) increased share of electrification on consumption side to 20.9%. It also provided an overview of the impact of various policies on energy savings across the country and CO2 emission reduction related monetary saving.

The information provided in this report will help in assessing the status of data availability of various energy products in the country. It can also help in analysing energy intensity of the country thereby enabling policy makers to formulate robust policies and carry out course correction more realistically.

There exists limited data on non-commercial energy sources such as biomass although these modes meet significant energy needs. There is possibility that a significant amount of data could be collected from government-subsidized projects and disseminated to be captured in the next editions of the report.

After various rounds of detailed consultation with all the line Ministries/Departments and stakeholder agencies the report has been finalized. A quick chapter wise overview of the report is presented below.

The **first chapter** of the report is an introduction about the nexus between energy consumption, economic development and emerging environmental problems linked to fossil fuel-based share of energy use. It also presents the imperative of statistics for assessing energy demand and supply trends.

The second chapter discuss out energy resources and products, energy flow, energy demand and energy supply, etc. It also details out Indian and internationally recommended units of measurement, energy consumer and classification which gives perspective on the similarities between them.

The **third chapter** is a detailed discussion on the supply of energy products in India from 2016-17 to 2021-22. It classified energy products into primary and secondary energy products in physical quantities.

The **fourth chapter** presents information about the energy consumption by various energy consumers from 2016-17 to 2021-22. It provides details on the sectoral consumption of various primary and secondary energy products in physical quantities.

The **fifth chapter** provides all the energy flow in the country from 2016-17 to 2021-22 in energy equivalent. It further presents the end-use of energy products for various consumers.

The **sixth chapter** presents initiatives being taken by EDMU in further improving the energy data reporting in India in sectors where it is difficult to collect such data at present.

The **seventh chapter** discusses the impact of various energy efficiency policies of Bureau of Energy Efficiency in industry, agriculture, transport, building, municipality sector.

The **eighth chapter** discusses the key findings and way forward of this report.

Best efforts have been made by EDMU team to address the inputs received from line ministries and departments. The inputs have been duly incorporated in the EDMU report for the year 2021-22 so the findings can be consolidated in a much comprehensive way. The report will aim for further improvement in its future publications.

Key highlights of the report are presented under three broad categories that include (i) value addition (ii) new insights (iii) Usefulness

Value Addition

» This report provides granular fuel-wise energy consumption data for various sectors. This detailing will enable a better understanding of the energy profile of various sectors, subsectors and consumer groups.

» The use of distinct conversion factors (of domestic coal and imported coal) for different years based on different calorific values of coal gives a realistic picture of coal-based energy supply and consumption in the country.

» In the latest edition of 2023 MoSPI Report, the conversion factors of coal have been derived using a weighted average methodology rather than using a single representative GCV for all grades of coal.

» This report also provides an overview of the impact of various policies on energy savings and CO2 emission reduction with corresponding monetary savings.

New Insights

» A decrease in energy supply by 18% from earlier approach in the year 2021-22.

» Lower energy consumption value by 8% in 2021-22.

» Increased share of electrification on consumption side to 20.9%.

Usefulness

» The information provided in this report will help in assessing the status of data availability of various energy products in the country.

» It can also help in analysing energy intensity of the country thereby enabling policy makers to formulate robust policies and carry out course corrections.

Way forward

» There exists limited data on non-commercial energy sources such as biomass although these modes meet significant energy needs.

» There appeared a need to bridge the existing gap in the exploration side of data (i.e., 2D, and 3D surveys).

» There is also a possibility that a significant amount of data could be collected from government-subsidized projects and disseminated and would be captured in the upcoming editions of the report.

Chapter 1: Introduction

1.1 Background

Energy is a critical input for economic and social development of a country as it determines it's prosperity level. However, it is a complex process to decipher the supply and end use of energy at various levels of Indian economy. Energy is a commodity that goes through a process of conversion in order to generate useful outputs. The network of energy system comprises of primary energy, secondary energy (electricity or fuels such as gasoline) final energy (heat, kinetic energy, light, etc.) and useful energy (end-use at sectors such as industry/agriculture/transport/household).

With a population of 1.4 billion, India has a massive demand for energy to fuel its rapidly growing economy. India as a country faces multi-facted energy challenges, which are thereby driving the sectors to also transform their energy use patterns. Industry being one of the largest energy consuming sectors, energy efficiency, switching to cleaner fuels, increasing penetration of renewable energy and decarbonization through CCUS, and modern fuels like green hydrogen are gaining traction and are essential to drive necessary transition in the long run.

From a power deficit nation at the time of Independence, the efforts to make India energy-independent have continued for over seven decades. Industrial investments in clean energy sources and enhancing energy efficiency are hailed as two of the most viable options for any country's decarbonisation efforts, at any level of development. Today, India is a power surplus nation with a total installed electricity capacity of over 400 GW.

Keeping in mind the sustainable development goals, India's power generation mix is rapidly shifting towards a more significant share of renewable energy. Today, India is the world's third largest producer of renewable energy, with 40% of its installed electricity capacity coming from non-fossil fuel sources.

India has ratified several international protocols and agreements on environmental protection like Paris Agreement and Sustainable Development Goals. India has also taken several initiates for promoting energy transition, energy security, energy efficiency and energy access. The Indian government has unveiled a range of policy instruments to support the development and deployment of renewable energy technologies and energy savings. It has introduced a National Green Hydrogen Mission, an amendment of the National Energy Conservation Act of 2001, National Electricity Plan, National policy on Biofuels etc. These policies are going to be instrumental in decarbonising India's industrial sector, and will provide greater opportunity for energy savings in energy end-use sectors.

Given the importance of energy, energy security and energy transition at the global and national level, a robust, consistent and reliable energy data can help understand the energy profile of a country. It also helps in assessing the impact of various policies. In contemporary times where energy transition holds high priority, robust energy data can help policy makers formulate data backed policies which would support country to achieve its environmental and developmental commitment in the coming years.

India already achieved a 34%-reduction in its national emission intensity by 2022 and is also expected to reach its 45% reduction commitment before 2030. The National Bioenergy Programme launched on 2nd November, 2022 comprises following sub-schemes:

» Waste to Energy Programme (Programme on Energy from Urban, Industrial and Agricultural Wastes/ Residues)

» Biomass Programme (Scheme to support Manufacturing of Briquettes & Pellets and Promotion of Biomass (non-bagasse) based cogeneration in Industries.

» Biogas Programme: for promotion of family type Biogas plants.

To facilitate large scale grid-connected solar power projects, a scheme for "Development of Solar Parks and Ultra Mega Solar Power Projects" is under implementation with a target capacity of 40 GW capacity by March 2024. Solar Parks provide solar power developers with a plug and play model, by facilitating necessary infrastructure like land, power evacuation facilities, road connectivity, water facility etc. along with all statutory clearances. As on 31-10-2022, 56 Solar Parks have been sanctioned with a cumulative capacity of 39.28 GW in 14 states. Solar power projects of an aggregate capacity of over 10 GW have already been commissioned in 17 parks and the remaining parks are at various stages of implementation. Solar projects of capacity 832 MW have been commissioned in various Solar Parks from January to October, 2022.

In the Independence Day address on 15 August 2021, Hon'ble Prime Minister announced the National Green Hydrogen Mission and stated the goal to make India the global hub of Green Hydrogen production and export.

Under the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahaabhiyan (PM-KUSUM) scheme government intends to provide energy and water security, de-dieselise the farm sector and also generate additional income for farmers by producing solar power, Government launched PM-KUSUM Scheme for farmers. The Scheme consists of three components:

» Component A: Installation of 10,000 MW of Decentralized Grid Connected Solar Power Plants each of capacity up to 2 MW

» Component B: Setting up of 20 lakh standalone Solar Powered Agriculture Pumps

» Component C: Solarisation of 15 Lakh existing Grid-connected Agriculture Pumps

The Scheme aims to add 30.8 GW of solar capacity with central financial support of over Rs. 34,000 Crore.

To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation, Government has taken up a mass movement for "LiFE" Lifestyles for Sustainable Environment a key to combat climate change.

1.2 Need for Robust Energy Statistics

Given the importance of energy security and energy transition at the global and national level, a robust, consistent and reliable energy data can help understand the energy profile of a country. An energy statistic is vital to trace the flow of different forms of energy in a country. It helps provide a true picture of how energy has been used in a country. To understand the consumer market for a country, one must be aware of the country's fuel security and perform a detailed study on the data set comprising fuel consumption corresponding to different sectors of end use. It forms the basis to develop indicators for each energy product's role in a country's economy.

Reliable and consistent energy data facilitates in assessing the effect of various policies. In the contemporary times where energy transition holds high priority, robust energy data can help policy makers formulate data backed policies. Along with facilitating in the estimation of CO_2 emissions with respect to the national territory, energy data can also be used as an input for modeling and forecasting. Therefore, to give a holistic picture of a country's energy sector and course correction to a sustainable path of development, compiling and dissemination of energy data is important.

Chapter 2: Energy Statistics: Key Concepts & Definitions

Energy holds importance for socio-economic development, therefore it's vital to understand the energy landscape of a country. A strong energy statistic can help planning a country's energy resources in the most efficient manner. Strengthening the energy data of a country requires it to be made uniform, consistent and internationally and temporally comparable. This requires clearly defining and standardizing key concepts related to energy flows.

Key energy concepts discussed in this chapter have been classified in four categories as shown in Figure 1. These concepts have been explained at length in this chapter.

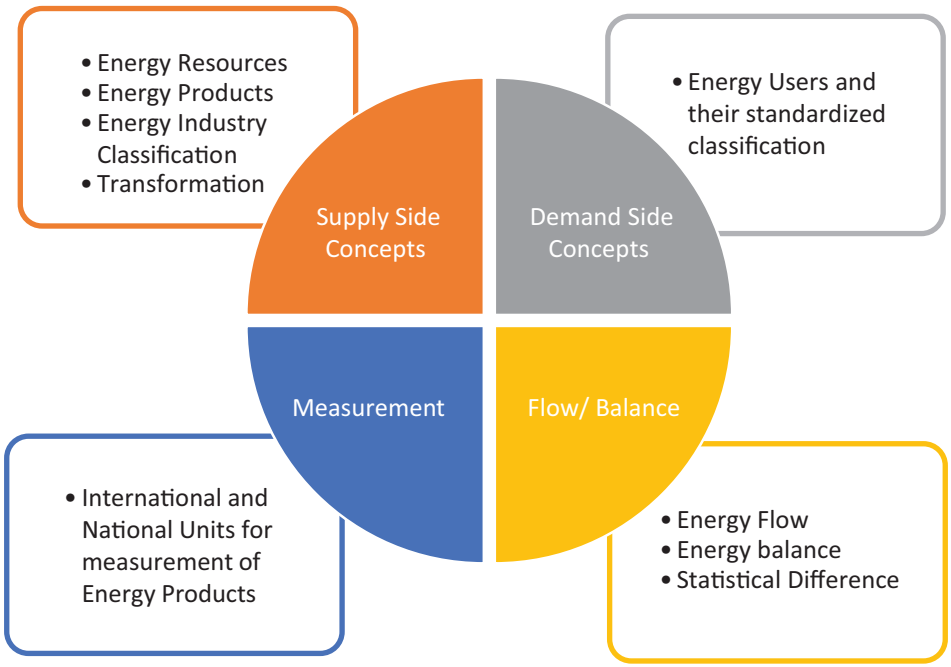

Figure 1: Key Energy Concepts Discussed in the Report

2.1 Supply and Demand Side Concepts

2.1.1 Defining Energy Resources and Reserves

Energy resources can be defined as the elements that can be used to produce energy. They include "all non-renewable organic as well as inorganic energy resources" discovered from the Earth's crust in solid, liquid or gaseous state. In general, everything that has the potential to be harnessed into useful product is called a resource. According to IRES (International Recommendation for Energy Statistics), 2018 energy resources include oil resources, natural gas resources, lignite, peat, uranium and other nuclear fuels. However, all the resources cannot be harnessed due to the technical infeasibility or the high environmental and economic costs associated with them.

Energy reserves can be defined as those resources that can be extracted from the Earth's crust based on technical, economic and environmental feasibility.

2.1.2 Understanding Energy Products

Energy product refers to the products that are used as a source of energy. The energy products are also transformed into other kinds of energy products prior to their consumption. Energy products are a subset of resources and they can be further classified as primary and secondary products.

Primary energy products can be extracted or captured directly from natural resources without changing their physical or chemical properties whereas the secondary energy products are those which are produced from transformation of primary or secondary energy products.

Examples of primary energy products include coal, crude oil, natural gas, biomass, and uranium. These primary energy products for instance, coal can be burned to generate heat and electricity, crude oil can be refined to produce gasoline, diesel, and other petroleum products, and biomass can be used to produce biofuels and renewable electricity are secondary energy products.

Energy products can be obtained from both renewable (e.g., solar, biomass, etc.) and non-renewable sources (e.g., crude oil, coal, etc.). This distinction between renewable and non-renewable energy products is necessary for energy planning and environmental concerns.

Distinction between primary and secondary energy products is not so straight forward and needs a careful understanding as depicted in Table 1.

Table 1: Primary and Secondary Energy Products as recommended in IRES

	Primary Products	Secondary Products
Non-Renewables	Hard Coal	Coal products
	Brown Coal	
	Peat	Peat products
	Natural Gas	
	Conventional Crude Oil	Refinery feedstock, Oil products like diesel, petrol, petcoke etc
	Additives and Oxygenates	
	Industrial Waste	Electricity and heat from combusted fuels of fossil origins
	Municipal Waste Nuclear Heat	Electricity derived from heat and chemical processes and nuclear heat Any other product derived from primary/secondary non-renewable products
		Heat from chemical Processes
	Nuclear Materials	Electricity from Nuclear Materials
Renewables	Biofuels (except charcoal)	Charcoal
	Municipal waste Heat from renewable sources except from combusted biofuels	Electricity and heat from combusted biofuels
	Electricity from renewable sources, except from geothermal, solar thermal or combusted biofuels	Electricity from geothermal and solar thermal Any other product derived from primary/ secondary renewable product

Source: IRES, 2011, United Nations

**Here only that municipal waste is considered as a energy product which is used for energy production.*

Table 2 classifies energy products into primary and secondary energy products. It further classifies energy products into renewable and non-renewable energy sources. It can be seen that energy products like coal, natural gas and crude oil are primary energy products, while their derivatives are secondary energy products.

2.1.3 Energy Industry and Consumers

Energy industries are defined as units across the entire value chain whose principal activity is production, transformation, or distribution of energy. These industries include coal mines, oil and gas exploration plants, coal washeries, energy transportation and distribution companies, energy storage companies, etc.

The IRES defines energy consumer as an economic unit (e.g. enterprises and households) that act as final user of energy.

Globally, Statistical Commission for United Nation recommends an International Standard Industrial Classification (ISIC) for all economic activities consisting primary production, secondary production and services. Being a part of the UN expert group, India adopted ISIC Rev. 4 as a basis to classify its industries called National Industrial Classification (NIC). Table 2 and Table 3 presents classification of energy industries and consumers based on ISIC and NIC classification.

Table 2: Energy Industry classification as per ISIC and NIC.

Energy Industry	ISIC Rev. 4	NIC Code
Electricity and heat plants	Division: 35—Electricity, gas, steam and air conditioning supply	Division: 35—Electricity, gas, steam and air conditioning supply
Coal mines	Division: 05—Mining of coal and lignite	Division 05 : Mining of coal and lignite
Coke ovens	Group: 191—Manufacture of coke oven products	Group: 191—Manufacture of coke oven products
Coal liquefaction plants	Group: 192—Manufacture of refined petroleum products	Group: 192—Manufacture of refined petroleum products
Patent fuel plants	Group: 192—Manufacture of refined petroleum products	Group: 192—Manufacture of refined petroleum products
Brown coal briquette plants	Group: 192—Manufacture of refined petroleum products	Group: 192—Manufacture of refined petroleum products
Gas works (and other conversion to gases)	Group: 352—Manufacture of gas; distribution of gaseous fuels through mains	Group: 352—Manufacture of gas; distribution of gaseous fuels through mains
Gas separation plants	Division: 06—Extraction of crude petroleum and natural gas	Division: 06—Extraction of crude petroleum and natural gas
Gas-to-liquids (GTL) plants	Division: 06—Extraction of crude petroleum and natural gas	Division: 06—Extraction of crude petroleum and natural gas
LNG plants/regasification plants	Group: 091—Support activities for petroleum and natural gas extraction Class: 5221—Service activities incidental to land transportation	Group: 091—Support activities for petroleum and natural gas extraction Class: 5221—Service activities incidental to land transportation

Table 2: Energy Industry classification as per ISIC and NIC.

Energy Industry	ISIC Rev. 4	NIC Code
Blast furnaces	Group: 241—Manufacture of basic iron and steel	Group: 241—Manufacture of basic iron and steel
Oil and gas extraction	Division: 06—Extraction of crude petroleum and natural gas Group: 091—Support activities for petroleum and natural gas extraction	Division: 06—Extraction of crude petroleum and natural gas Group: 091—Support activities for petroleum and natural gas extraction
Oil refineries	Group: 192—Manufacture of refined petroleum products	Group: 192—Manufacture of refined petroleum products
Charcoal plants	Class: 2011—Manufacture of basic chemicals	Class: 2011—Manufacture of basic chemicals
Biogas production plants	Group: 352—Manufacture of gas; distribution of gaseous fuels through mains	Group: 352—Manufacture of gas; distribution of gaseous fuels through mains
Nuclear fuel extraction and fuel processing	Class: 0721—Mining of uranium and thorium ores Class: 2011—Manufacture of basic chemicals	Class: 0721—Mining of uranium and thorium ores Class: 2011—Manufacture of basic chemicals
Other energy industry not elsewhere specified	Class: 0892—Extraction of peat	Class: 0892—Extraction of peat

Source: IRES, 2018, United Nations and National Industrial Classification (All Economic Activities), 2008[1]

[1] Industries in ISIC and NIC are classified in Divisions. These divisions are further classified into Groups, which are further divided into class and sub-class. Divisions are two digit classification of industries, while group, class and sub-class are identified with three, four and five digit classification respectively.

Table 3: Energy Consumer classification as per ISIC and NIC

Energy Consumer	ISIC Rev. 4	NIC Classification
Iron and Steel	Group 241 and Class 2431	Group 241 and Class 2431
Chemical and petrochemical	Divisions 20 and 21	Divisions 20 and 21
Non-ferrous metals	Group 242 and Class 2432	Group 242 and Class 2432
Non-metallic minerals	Division 23	Division 23
Transport equipment	Divisions 29 and 30	Divisions 29 and 30
Machinery	Divisions 25, 26, 27 and 28	Divisions 25, 26, 27 and 28
Mining and Quarrying	Divisions 07 and 08, and Group 099	Divisions 07 and 08, and Group 099
Food and Tobacco	Divisions 10, 11 and 12	Divisions 10, 11 and 12
Paper, pulp and print	Divisions 17 and 18	Divisions 17 and 18
Wood and Wood products (other than pulp paper)	Division 16	Division 16
Textile and leather	Divisions 13, 14 and 15	Divisions 13, 14 and 15
Construction	Divisions 41, 42 and 43	Divisions 41, 42 and 43
Industries not elsewhere specified	Divisions 22, 31 and 32	Divisions 22, 31 and 32
Household	Divisions 97 and 98	Divisions 97 and 98
Commerce and public services	Divisions 33, 36–39, 45–96 and 99, excluding ISIC 8422	Divisions 33, 36–39, 45–96 and 99, excluding ISIC 8422
Agriculture, forestry	Divisions 01 and 02	Divisions 01 and 02
Fishing	Divisions 03	Divisions 03
Not elsewhere specified (including defence activities)	Class 8422	Class 8422

Source: IRES, 2018, United Nations and National Industrial Classification (All Economic Activities), 2008

It can be seen in the tables above (Table 2, Table 3), that Indian classification of energy producer and consumers is similar to ISIC classification. Therefore, it can be concluded that Indian classification of industries are in consonance with international classification.

Apart from the energy producers mentioned in the Table 2, there are 'other energy producers'. Other Energy Producers are economic units (including households) that choose, or are forced by circumstance, to produce energy for their own consumption and/or to supply energy to other units, but energy production is not their principal activity. These units are engaged in the production, transformation and transmission/distribution of energy as a secondary and/or ancillary activity. Energy production is carried out as a supporting activity to principal activity of the economic unit, for example Iron and Steel plants

often produce their own coke and electricity, sugar mills nearly always burn the bagasse they produce for generating steam, and process heat and electricity, many industrial establishments and commercial organizations may have electricity-generating equipment. The IRES recommends recording production of energy by 'Other Energy Producers' in 'transformation' and 'energy industry own use'

2.1.4 Transformation Process

Transformation is the process where part or all of the energy content of a product entering a process moves from this product to one or more different products leaving the process (e.g., from coking coal to coke, from crude oil to oil products, or from fuel oil to electricity).

Transformation processes play a vital role in the flow of energy throughout an economy, as they ensure that primary energy products that cannot be directly or effectively utilized are changed into other energy products more suitable for consumption. It is important to identify such processes in order to describe and analyse energy transformation more precisely and assess the resources necessary for carrying it out.

2.2 Measurement, Flow and Balancing Concepts

2.2.1 Measurement Units

Energy products are measured in terms of mass, volume and energy content. Unit of measurement of energy product employed at the point of measurement is called "original" or "natural" unit and depends on the type of energy product. For example, coal is measured in terms of mass, while oil and petroleum products are measured in volume terms.

The energy balance which does a cross-fuel tabulation, needs all energy products to be displayed in "common" energy units. This requires the conversion of "original" units into "common" units by using correct conversion factors.

The SI unit for energy is Joule and is the common energy unit used in energy statistics. Common multiples of the Joule are the Megajoule, Gigajoule, Terajoule and Petajoule. There are other units for measurement of energy like toe (Tonnes of oil equivalent), kcal (kilocalorie), kilowatt hour (kWh) and/ or its multiples.

Table 4 presents the measurement units as per international standards and Indian standards classification. It can be seen that there is no significant difference between Indian and IRES suggested units of energy product measurement except for (Liquid) Biofuels, Gases, Wastes and Refinery capacity.

Table 4: Units used for Energy product measurement as recommended by IRES and those used in India

Energy Product	Dimension	IRES Unit	Indian Unit (Quantity)
Solid Fossil Fuels	Mass	Thousand Metric Tonnes (TMT)	Million Tonnes (MT)
Liquid fossil fuels (crude oil, petroleum products, condensate)	Mass/ Volume	Thousand Metric Tonnes (TMT)	Thousand Metric tons / Million Metric Tonnes (MMT)
(Liquid) Biofuels	Mass/ Volume	Thousand Metric Tonnes/ Thousand Cubic Meters	Crore Liters
Gases	Energy	Terajoules (TJ)	Million metric standard Cubic Meters
Wastes	Energy	Terajoules	Million Metric Tonnes
Fuelwood	Energy	Thousand Cubic Meters/ Terajoules	Kilogram
Charcoal	Mass	Thousand Metric Tonnes	Tonnes
Electricity	Energy	GWh	GWh
Heat	Energy	Terajoules	Joules
Common unit (eg., balances)	Energy	Terajoules	Ktoe/Terajoules
Electricity installed capacity	Power	MW	MW
Refinery Capacity	Mass/ time	Thousand Metric Tonnes/ Year	Million Metric Tonnes Per Annum

Source: IRES and Report of the Inter-Ministerial Committee on Energy Data Management.

Since energy products are available in different forms, they are measured in different units. Therefore, to make energy data comparable there is a need to convert data in uniform energy terms. Countries may collect data in units that are convenient for them; however, for data dissemination, it is recommended that data is presented in the form that is internationally standardized. This allows energy data to become internationally comparable.

2.2.2 Energy Flow

Energy flows represent the complete value chain from energy production to its consumption. Energy products first appear in a reference territory[2] either through imports or production. Some energy products are used directly in their natural form, some are transformed before final consumption both for

[2] Reference Territory means the geographical scope of the energy statistics compiled. In energy statistics and energy balance is the national territory, (i.e., the geographical territory) under the economic control of the national government.

energy and non-energy purposes as shown in the figure below. The final consumers of energy products are different sectors including agriculture, mining and households within the reference territory. Once produced and/or transformed, energy products can be: (a) exported to other territories; (b) stored for later use (entering into stock); (c) used for refueling of ships and airplanes engaged in international voyages; (d) used by the energy industries themselves; and/or (e) delivered for final consumption.To create energy balance, final energy consumption[3] is further disaggregated according to the type of economic activities. Use of energy resources in power sector are identified independently from economic sectors. Figure 2 is a diagrammatic representation of Energy flow in an economy.

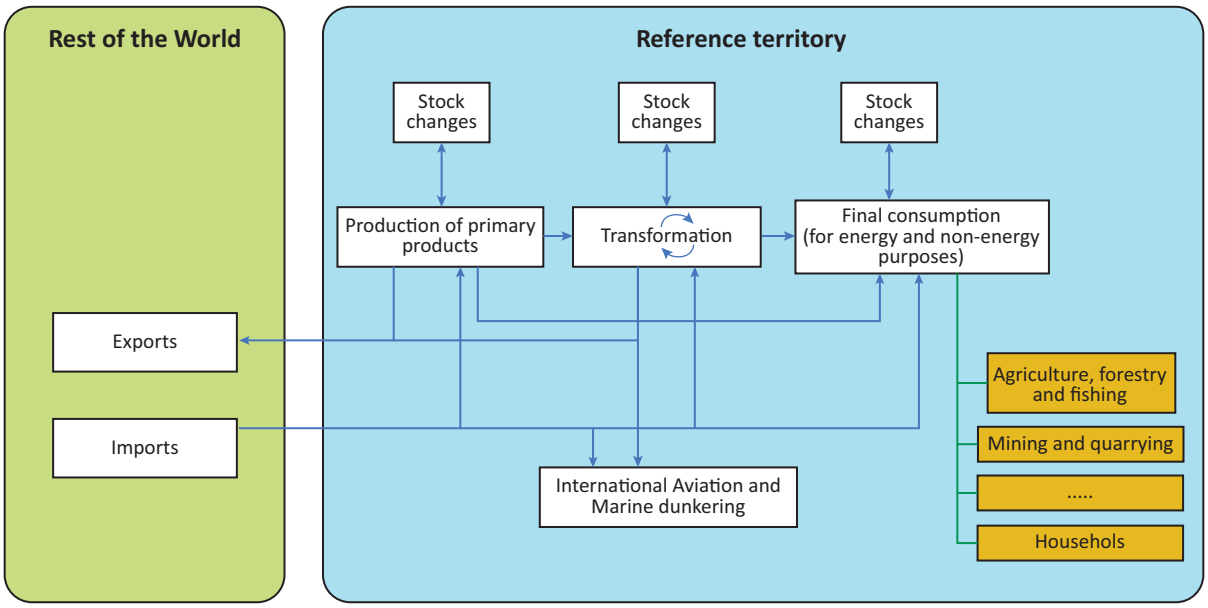

Figure 2: Energy Flow in an economy

Source: IRES, 2018, United Nation

2.2.3 Energy Balance

The basic energy statistics refer to statistics on energy stocks and flows, energy infrastructure, performance of the energy industries, and the availability of energy resources within the national territory of a given country during a reference period. Energy balances are an accounting framework for the compilation and reconciliation of data on all energy products entering, exiting and used within a national territory of a country in a reference period.

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[3] The final energy consumption of energy products consists of (a) final energy consumption, i.e. deliveries of energy products to the users located in the territory of reference for their energy needs, such as, transportation and electricity, and (b) non-energy use, i.e. deliveries of energy products for use as chemical feedstocks or as raw materials.

The energy balance should be as complete as possible so that all energy flows are, in principle, accountedfor. It should be based firmly on the first law of thermodynamics, which states that the amount of energy within any closed system is fixed and can neither be increased nor diminished unless energyis brought into or sent out from that system. The energy balance is compiled with respect to a clearly defined reference period. In this respect, it is recommended that countries, as a minimum, compile anddisseminate an energy balance on an annual basis.

Commodity balance provides the balance for each energy commodity in measurement units usually associated with that commodity. Whereas Energy balance presents the commodity balances in a common unit (in energy units) and places them adjacent to one another in a manner that shows the dependence of the supply of one commodity on another. Both commodity and energy balances show the flow of the commodity from its production, extraction or import through to its final use.

2.2.4 Statistical Difference

Statistical difference represents the numerical difference between the total supply of energy product and its total consumption. It is calculated by deducting total energy consumption from total supply of energy products. Statistical differences in energy accounting can arise due to several reasons like different spatial coverage, use of data for different time periods. Statistical differences can also arise when converting volume or mass into energy terms. For example, using of a single conversion factor for all grades of coal can reflect in statistical difference in energy balance. Use of sampling for energy data collection (for example, in case of collecting household energy consumption data) will reflect in statistical difference in the supply of energy products and total energy consumption.

In-depth understanding and clarity of concepts related to energy is a prerequisite before starting the task of preparing an energy balance. The standardized definitions used in this chapter is used for compiling energy data in the succeeding chapters.

Chapter 3: Energy Supply: Trends and Analysis

Understanding the energy sector dynamics of a country may help answer critical questions pertaining to the primary energy supply of a country. Several factors such as demand fluctuation, energy policy developments, price and accessibility influence energy supply and energy supply data provides relevant information on energy security and energy dependency of a country. The current chapter is an attempt to compile data on energy supplied by various energy products in India. This chapter discusses energy production/ supply of various energy resources as identified in Chapter 2 of the report.[4]

Energy products in this chapter have been described using the classification as primary and secondary energy products, as given in Table 2 of Chapter 2.

3.1 Primary Energy Supply

3.1.1 Coal

India has rich deposits of coal. Total estimated reserves of coal as on 01-04-2022 were 361411.46 MT (Millon Tonnes). Available in abundance, coal caters to almost half of India's energy requirement. Major producers of coal are Coal India Limited (CIL) and Singareni Collieries Company Limited (SCCL). CIL produced 86.95% (622.64 MT) of total coal production (716.08 MT) and SCCL produced 7.06% (50.58MT) of total production in the year 2020-21. (*Ministry of Coal 2023*)

Non coking coal is used in power generation in India, while coking coal is used in industries like Iron and Steel. India is also an importer of coal. India imports high grade coking coal to be used for production of coke. Its imports stood at 214.99 MT in 2020-21 For preceding years, India's imports stood at 235.3 MT (2018-19), 248.5 MT (2019-20) (*TEDDY 2021-22, 2022.*), it became to 208.9 MT in 2021-22. Of the total coal import, share of coking coal was 21.78% in 2016-17 and 23.8 % in 2020-21 whereas the share of non-coking coal was 78.1% in 2016-17 and 76.1% 2020-21. The data shows that the import of non-coking coal is higher than coking coal. India mostly imports coal from Indonesia and Australia, while its major exports go to Nepal.

Table 5 represents coal supply in India (domestic production, import and export) from 2016-17 to 2021-22.

[4] Data on biomass production on aggregate level could not be captured due to unavailability.

Table 5: Coal Supply in India from 2016-17 to 2021-22, in MT

	Coking			Non-coking			Total		
	Production	Import	Export	Production	Import	Export	Production	Import	Export
2016-17	61.7	41.6	0.02	596.2	149.3	1.7	657.9	191.0	1.8
2017-18	40.1	47.0	0.06	635.3	161.2	1.4	675.4	208.2	1.5
2018-19	41.1	51.8	0.100	687.6	183.5	1.2	728.7	235.3	1.3
2019-20	52.9	51.8	0.001	677.9	196.7	1.0	730.9	248.5	1.0
2020-21	44.8	51.3	0.003	671.3	163.7	0.8	716.1	215.0	0.8
2021-22	51.7	57.1		726.5	151.7		778.1	208.9	

Source: Provisional Coal Statistics, 2020-21, Ministry of Coal, 2023

As per Table 5, the total production of coal has increased by 2% CAGR from year 2016-17 to 2021-22. The coal production touched 730 MT in the financial year 2019-20 and 716 MT in the financial year 2020-21 despite COVID19 pandemic.

Table 6 represents detailed grade wise coking and non-coking coal production from year 2016-17 to 2020-21. As can be seen in the table, G11 is the most produced coal grades in India. Non-coking coal production far exceeds that of coking coal production. Production of G11 increased from 143 tonnes in 2016-17 to 194 tonnes in 2020-21. Production of G 15 have shown the highest growth rate of 68% CAGR respectively.

Table 6: Production of Grade wise Coking and Non-Coking Coal in India from 2016-17 to 2020-21, in MT

Type	Grade	2016-17	2017-18	2018-19	2019-20	2020-21
Production of Coking Coal	Steel-I	0.0	0.2	0.0	0.0	0.0
	Steel-II	1.0	0.1	-	0.1	0.0
	SC-1	0.1	0.2	0.2	0.3	0.2
	Wash-I	0.3	0.2	0.1	0.1	0.2
	Wash-II	3.4	4.6	4.3	2.3	2.4
	Wash-III	10.8	4.0	6.6	7.4	1.8
	Wash-IV	46.0	31.0	29.9	33.1	26.9
	Wash-V				9.6	12.8
	Wash-VI				0.0	0.4
	SLV1		-	0.0	-	-
	Met.Coal	15.3	32.9	34.0	35.5	32.3
	Non Met	46.3	7.3	7.1	17.5	12.5
	Total Coking	61.7	40.1	41.1	52.9	44.8

Table 6: Production of Grade wise Coking and Non-Coking Coal in India from 2016-17 to 2020-21, in MT

Type	Grade	2016-17	2017-18	2018-19	2019-20	2020-21
Production of Non-Coking Coal	G1	2.4	1.7	0.1	0.0	0.0
	G2	0.3	0.3	0.5	0.3	0.0
	G3	5.3	3.5	3.3	3.2	2.7
	G4	17.3	14.5	15.5	14.5	14.2
	G5	13.6	14.7	12.5	14.6	9.7
	G6	14.1	10.9	7.9	4.6	4.3
	G7	35.6	36.8	41.3	40.9	37.4
	G8	29.6	41.0	54.4	45.5	47.7
	G9	38.9	27.5	35.6	37.9	36.7
	G10	98.2	91.5	84.2	78.1	69.9
	G11	143.2	180.0	199.7	193.9	194.7
	G12	91.8	53.4	66.3	71.6	73.3
	G13	90.9	101.7	111.2	86.9	80.9
	G14	6.4	44.6	41.0	58.8	66.3
	G15	3.3	7.9	6.9	17.6	26.2
	G16	4.5	3.5	3.8	4.0	6.8
	G17	0.5	1.5	3.1	5.3	0.2
	Ungraded	0.3	0.1	0.1	0.2	0.2
	Total Non-Coking	**596.2**	**635.3**	**687.6**	**677.9**	**671.3**
	Total Coal	**657.9**	**675.4**	**728.7**	**730.9**	**716.1**

Source: Provisional Coal Statistics, 2020-21

3.1.2 Crude Oil

The estimated reserves of crude oil in India as on 01-04-2022 stood at 651.77 MT against 591.92 MT in the previous year. Geographical distribution of Crude oil indicates that the maximum reserves are in the Western Offshore (39%) followed by Assam (26%) (*IPNG-2021-22, 2022.*). Production of crude oil in the country was 29.6 MT during 2021-22, while it was 32.2 MT in 2018-19. There has been a 4% CAGR decline in crude oil production in India.

In terms of domestic crude oil production, two national companies ONGC (Oil and Natural Gas Corporation) and OIL (Oil India Limited) are the key players in the country having a share of around 66% and 10% respectively in 2021-22. (*TEDDY 2021-22, 2022*).

India mostly imports crude oil including petroleum products from countries such as Saudi Arabia, Iran, USA, UAE, Nigeria, Kuwait, Mexico, Angola, Oman, and Qatar. Domestic production and import of crude oil in India from 2016-17 to 2021-22 are given in the Table 7.

India has emerged as a crude oil refining hub in Asia. Production of various petroleum products is discussed in the section 3.2.2.

Table 7: Source of Crude Oil in India, in MT

	Domestic Production	Import
2016-17	36.01	213.9
2017-18	35.68	220.4
2018-19	34.20	226.5
2019-20	32.17	227.0
2020-21	30.49	196.4
2021-22	29.69	212.0

Source: IPNG Statisticstics, 2021-22

As per the above table, India's crude oil production has been declining during the past few years. From 36.01 MT 2016-17, it declined to 35.68 MT in 2017-18, to 29.69 MT in 2021-2022. Crude Oil production has declined by 4% CAGR from 2016-17 to 2021-22. Import of crude oil increased from 2016-17 till 2019-20 after which it declined.

3.1.3 Natural Gas

The estimated reserves of Natural Gas in India as on 01-04-2022 stood at 1138.67 BCM against 1372.37 BCM in previous year.

Natural Gas is used in power, transport (CNG vehicle fuel), and household for cooking and as feedstock in industries. Power and fertilizer sector are the two biggest natural gas consumers in India, accounting for more than 55% of total gas consumption in India (*Vision-NGPV-2030*).

Table 8 summarizes the domestic production and import of natural gas in India from 2016-17 to 2021-22. To maintain uniformity in data, sources of natural gas have been quantified in BCM.

It can be seen from the table that India imports almost same amount of natural gas as it produces domestically. From 2016-17 to 2021-22, domestic production of natural gas has increased by 1% CAGR, while imports have increased by 4% CAGR.

Table 8: Source of Natural Gas in India, in BCM

	Domestic Production	Import
2016-17	31.90	24.85
2017-18	35.65	27.44
2018-19	32.87	28.74
2019-20	31.18	33.89
2020-21	28.67	33.03
2021-22	34.02	30.78

Source: IPNG Statistics, 2021-22

As natural gas is considered to be a cleaner fuel than coal and petroleum, Government has set a target to increase the share of gas in India's primary energy mix from 6.3% in 2021 to 15% in 2030. Government initiatives include providing support for compressed biogas, National Gas Grid for pipeline infrastructure, city gas distribution Network and LNG regasification terminals (PIB Delhi, 2022).

3.1.4 Electricity (Renewable)

Renewable Electricity is produced from primary sources like solar, wind, hydropower and waste. India has made substantial progress in renewable energy installations.

In terms of share, hydro has the largest share in installed capacity, followed by solar and wind. As per MNRE, India stands 4th globally in renewable energy installed capacity (including large hydro) 4th in wind power capacity and 4th in solar power capacity (*Year- End Review 2022- Ministry of New and Renewable Energy,2022*).

Figure 3 shows gross electricity generation from various energy resources in India from 2016-17 to 2021-22. In terms of growth rate, there is a 4% CAGR growth in gross electricity generation from hydro power, while there is a 10% CAGR growth in renewable energy sources from 2016-17 to 2021-22.

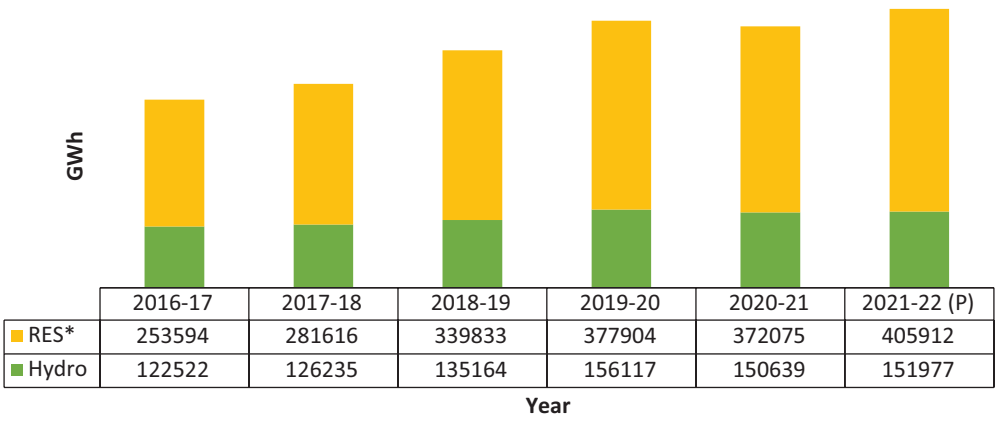


Figure 3: Gross electricity generation from various renewable energy sources in India from 2016-17 to 2021-22, in GWh

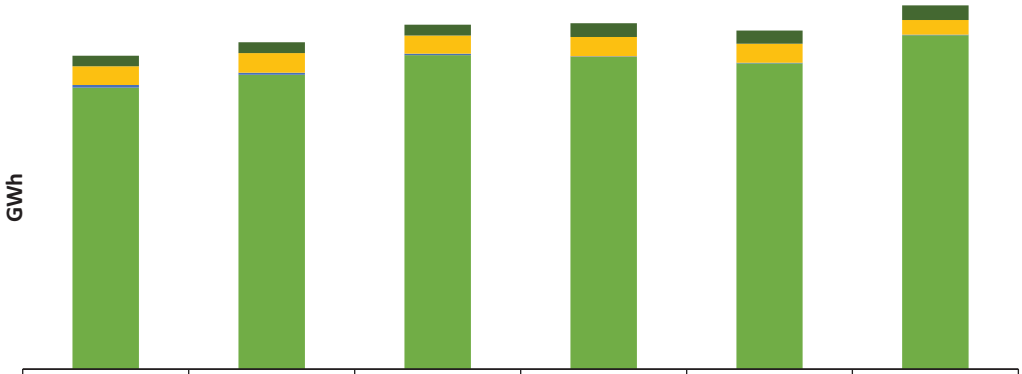
Source: General Review and Annual Report, CEA

3.2 Secondary Energy Supply

3.2.1 Electricity (Non-Renewable)

Electricity produced from thermal and nuclear material or any other combustible fossil fuels is considered as secondary energy source. The share of thermal-based power plant has the largest share in India's power sector. Figure 4 depicts trends in gross electricity generation of thermal and nuclear power plants. Installed thermal capacity has been disaggregated into steam, diesel and gas.

From the Figure 4 below, it can be seen that gross electricity generation of thermal sources has shown a growth of 3% CAGR, while there is a 7% CAGR growth in gross nuclear power generation.



	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22 (P)
Nuclear	40,193	40,674	41,487	52,782	50,187	55,612
Gas	71,949	75,570	69,379	73,886	72,628	56,066
Diesel	9,583	8,455	5,549	2,118	2,728	2,293
Steam	10,81,610	11,30,459	12,06,515	11,99,743	11,74,586	12,82,581

Figure 4: Gross Electricity Generation of electricity (Utility+ Non-Utility) from Thermal and Nuclear sources in India from 2016-17 to 2021-22, in GWh

Source: General Review and Annual Report, CEA

3.2.2 Petroleum Products

There has been a spectacular growth in India's refining sector over the years. India has now achieved self-sufficiency in refining, and is now a major exporter of quality petroleum products. Today India is the global refining hub with refining capacity of 251.2 MMTPA and is the fourth largest in the world after

the United States, China and Russia. There are 23 refineries in the country; 19 in the Public Sector, 1 as Joint Venture and 3 in the Private Sector. They are well spread geographically and are connected with cross country pipelines (REFINING - HISTORY AND EVOLUTION | Ministry of Petroleum and Natural Gas | Government of India, 2023, Oil & Gas Industry in India, 2022). Production of petroleum products has increased from 244 MT in 2016-17 to 254 MT in 2021-22.

Table 9 summarizes the domestic production, import, export and consumption of various petroleum products in India in 2021-22.

Table 9: Domestic Production, Import, Export and Consumption of various Petroleum Products in India in 2021-22, in MT

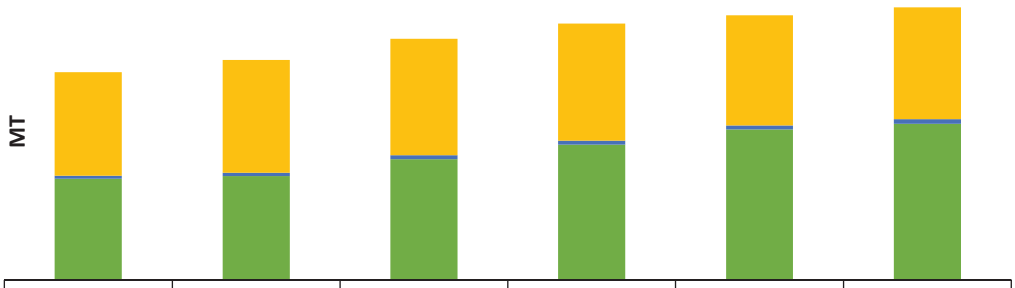
	Production	Import	Export	Consumption
LPG	12.2	17.1	0.5	28.3
Petrol	40.2	0.6	13.5	30.8
Naphtha	20.0	1.3	6.9	14.3
ATF	10.3	-	5.2	5.0
Diesel (HSD+LDO)	108.0	0.07	32.4	77.7
Lubes/Greases	1.2	3.1	0.0	4.6
Bitumen/Asphalt	5.1	2.6	0.0	7.9
Petroleum Coke	15.5	5.7	0.2	15.8
Others	41.7	12.1	4.1	19.8

Source: IPNG, 2021-22

The following sections discuss production and trade of the above mentioned (in Table 9) petroleum products in detail.

3.2.2.1 Liquefied Petroleum Gas

Liquefied Petroleum Gas (LPG) is a mixture of liquefied hydrocarbons, mainly propane and butane gases and is highly flammable. Its high heating value makes it popular in the heating industry. It is used by households for cooking purposes and in automobiles.



	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Domestic Production	11.3	12.4	12.8	12.8	12.1	12.2
Exports	0.3	0.4	0.4	0.5	0.5	0.5
Imports	11.1	11.4	13.2	14.8	16.5	17.1

Year

Figure 5: Domestic Production, Import and Export of LPG in India from 2016-17 to 2021-22, in MT

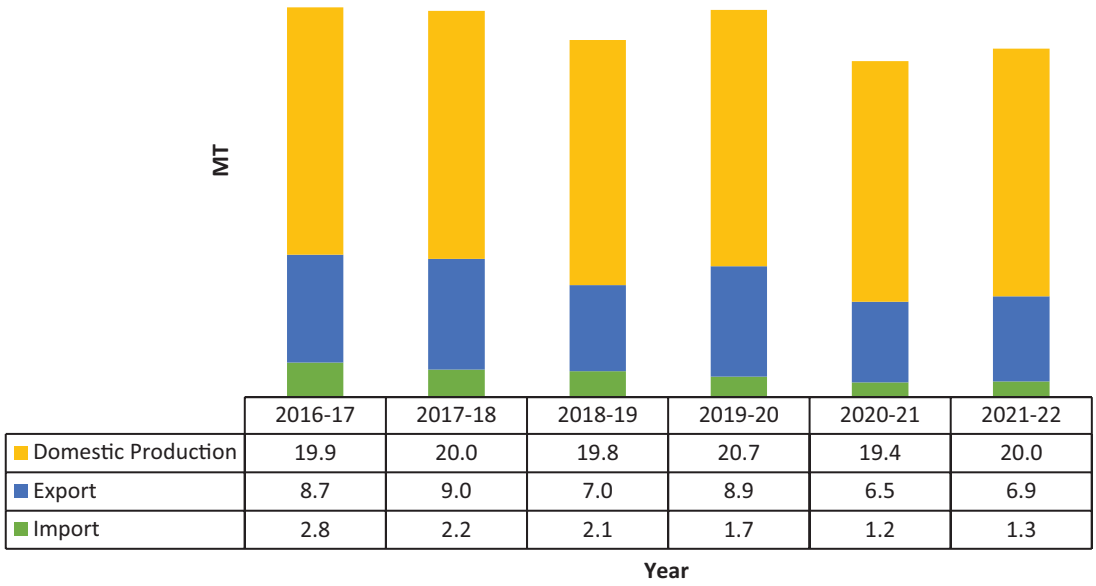
Source: IPNG Statistics, 2022

Figure 5 presents the trend of domestic production, import and export of LPG over the last 6 years. From 2016-17 to 2021-22 India's domestic production of LPG has grown at a CAGR of 2%, while growth of exports surpassed imports. The table also highlights the fact that India depends heavily on LPG imports to meet the domestic demand. In 2016-17, India's import of LPG was more than its domestic production. India's import dependence on LPG started reducing only after 2018-19. In 2021-11, India imported 71% more of its domestic production of LPG.

3.2.2.2 Naphtha

Naphtha is a highly flammable volatile liquid hydrocarbon mixture and is used as a solvent in various industries. In industrial use, naphtha serves as a raw material for producing plastics like polyethene and polypropylene. Moreover, different naphtha chemicals are used as a raw material for generating petrochemicals containing gasoline and butane.

Figure 6 below shows the production, import and export of naphtha in India and it can be seen that the import dependency of naphtha has reduced continuously over the years. It has declined by 15% CAGR, while exports have declined by 5% CAGR. Domestic production of Naphtha has remained almost constant in the last six years.



	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Domestic Production	19.9	20.0	19.8	20.7	19.4	20.0
Export	8.7	9.0	7.0	8.9	6.5	6.9
Import	2.8	2.2	2.1	1.7	1.2	1.3

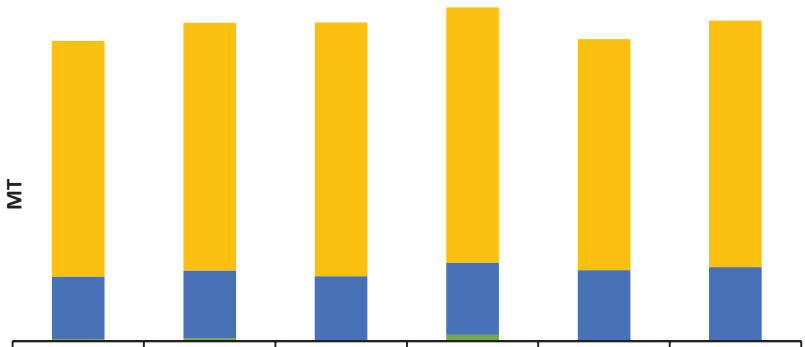
Figure 6: Domestic Production, Import and Export of Naphtha in India from 2016-17 to 2021-22, in MT

Source: IPNG Statistics, 2022

3.2.2.3 Diesel

Diesel fuel is the common term for the distillate fuel oil sold for use in motor vehicles that run with compression ignition engines. Most freight and delivery trucks as well as trains, buses, boats, and farm, construction, and military vehicles, and some cars and light trucks have diesel engines. Diesel fuel is also used in diesel-engine generators to produce electricity.

Figure 7 shows the trend of domestic production, import and export of diesel over the last 6 years and it can be seen that diesel exports are significantly higher than the imports. In 2016-17 India exported 26% of its domestic production, while this share increased to 30% in 2021-22. Diesel import reduced by 41% CAGR from 2016-17 to 2021-22.



	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Domestic Production	103.1	108.5	111.2	111.8	101.2	108.0
Export	27.5	29.7	27.9	31.7	30.6	32.4
Import	1.0	1.4	0.6	2.8	0.6	0.1

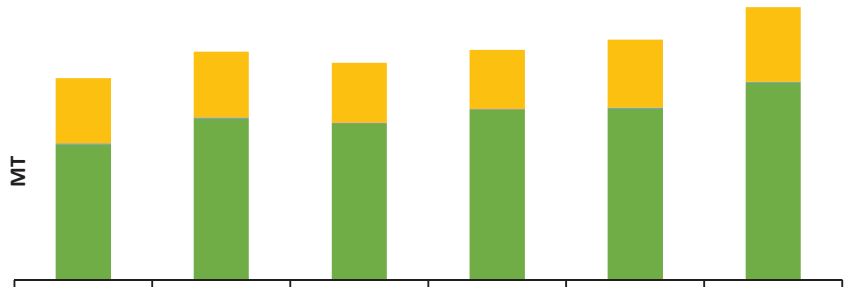
Figure 7: Domestic Production, Import and Export of Diesel in India from 2016-17 to 2021-22, in MT

Source: IPNG Statistics, 2022

3.2.2.4 Petroleum Lubricant

Petroleum-based lubricants are extracted from natural crude oil, and must be refined, desalted, dewaxed, and distilled from crude feedstock. Lubricants are used to reduce friction between surfaces. Oil, Grease, Penetrating Lubricants, and Dry Lubricants are some commonly used petroleum lubricants.

Figure 8 below shows the production, import and export of petroleum lubricants in India. Import of petroleum lubricants has increased by 8% CAGR while exports have witnessed a decline. It can be seen that imports of petroleum lubricants are more than twice the domestic production for all the years, therefore stating that India is dependent on imports to meet its domestic demand for petroleum lubricants.



	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Domestic Production	1.03	1.04	0.95	0.93	1.07	1.17
Export	0.01	0.01	0.01	0.01	0.02	0.01
Import	2.13	2.54	2.46	2.68	2.69	3.11

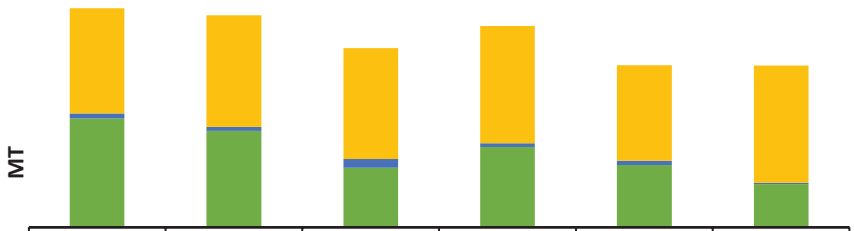
Figure 8: Domestic Production, Import and Export of Petroleum Lubricants in India from 2016-17 to 2021-22, in MT

Source: IPNG Statistics, 2022

3.2.2.5 Petcoke

The crude oil extracted from Earth is processed or refined to get gasoline, lubricating oils, waxes, and jet fuel. The residual crude undergoes further processing or "Coking" to get Petcoke/ Petroleum Coke. It is a highly stable, carbonaceous solid fuel which is not considered hazardous.

Figure 9 shows the trend of domestic production, import and export of Petcoke over the last 6 year. In 2016-17, India imported almost the same amount of petcoke as its domestic production, but in subsequent years, there has been a fall in import of petcoke. In 2021-22, this share reduced to 37% of total domestic production. Import of petcoke has declined by 17% CAGR from 2016-17 to 2021-22.



	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Domestic Production	13.9	14.8	14.7	15.5	12.7	15.5
Export	0.7	0.6	1.1	0.5	0.6	0.2
Import	14.4	12.8	7.9	10.7	8.3	5.7

Figure 9: Domestic Production, Import and Export of Petcoke in India from 2016-17 to 2021-22, in MT

Source: IPNG Statistics, 2022

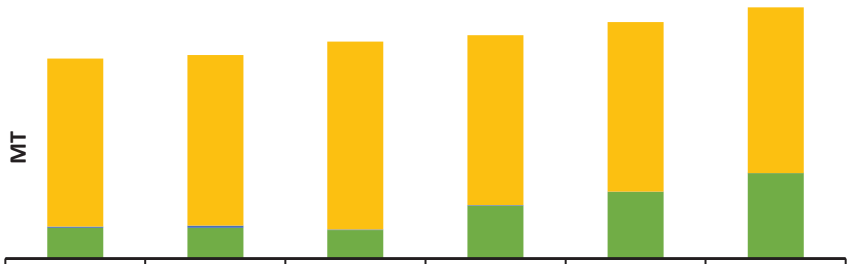
3.2.2.6 Bitumen

The term bitumen refers to a substance produced through the distillation of crude oil. Bitumen is known for its waterproofing and adhesive properties and is commonly used in the construction industry, notably for roads and highways. Production occurs through distillation, which removes lighter crude oil components like gasoline and diesel, leaving the heavier bitumen behind.

Figure 10 shows the trend of domestic production, import and export of Bitumen over the last 6 years and it can be deduced that we depend on significant amount of imports to meet demand for Bitumen. Import of bitumen has increased at a CAGR of 23%, while domestic production has remained the same. Import of Bitumen increased from 18% of domestic production in 2016-17 to 52% of domestic production in 2021-22.

3.2.2.7 Petrol

Petrol, also known as gasoline or gas, is a petroleum-derived liquid fuel primarily used as a fuel for internal combustion engines in vehicles, such as cars, motorcycles, and small aircraft. Petrol is a mixture



	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Domestic Production	5.19	5.28	5.80	5.24	5.25	5.11
Export	0.04	0.06	0.02	0.03	0.01	0.01
Import	0.95	0.95	0.88	1.63	2.06	2.64

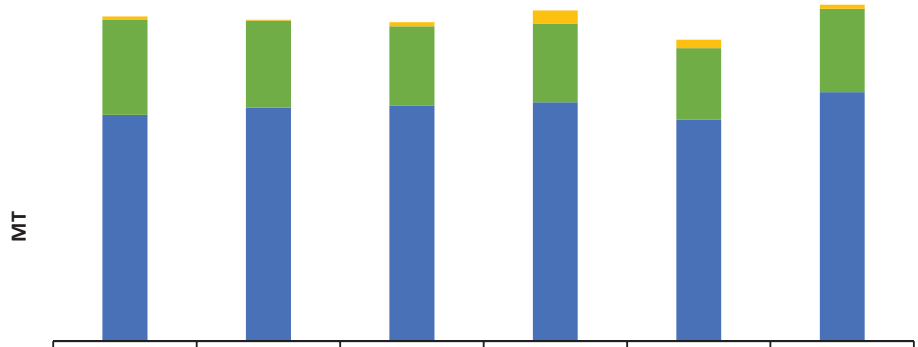
Figure 10: Domestic Production, Import and Export of Bitumen in India from 2016-17 to 2021-22, in MT

Source: IPNG Statistics, 2022

of hydrocarbons, consisting of mostly alkanes, cycloalkanes, and aromatic hydrocarbons. While petrol is widely used as a transportation fuel, it is also used in other applications, such as powering small engines, generators, and lawn mowers. It can be seen from the Figure 11 that production of petrol has increased at 2% CAGR.

3.2.2.8 Share of Energy Product in Total Energy Supply

To examine the contribution of various energy products in India, Figure 12 has been compiled by converting supply of energy products in India (in quantity) into energy equivalent (in ktoe). It can be seen from the figure that coal supplies almost 60% of India's total energy supply, followed by diesel.



	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Import	0.48	0.17	0.67	2.15	1.35	0.671
Export	15.42	14.04	12.88	12.71	11.61	13.48
Production	36.59	37.78	38.04	38.62	35.78	40.24

Figure 11: Supply of Petrol in India from 2016-17 to 2021-22, in MT

Source: IPNG Statistics, 2022

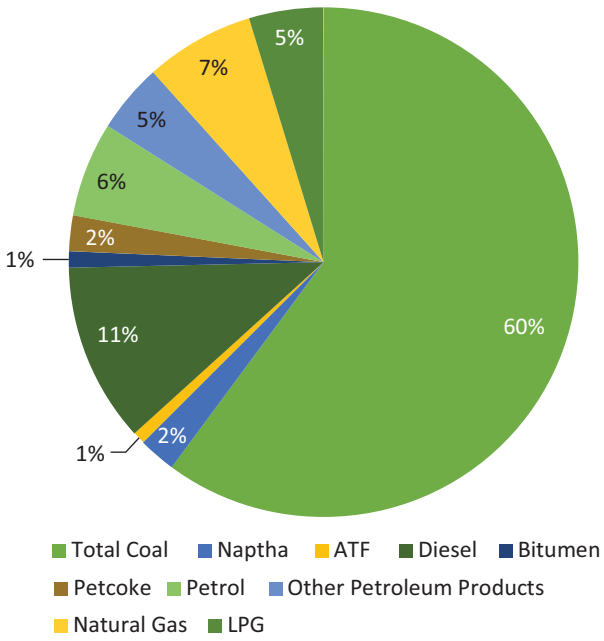


Figure 12: Percentage share of various energy products in Primary Energy Supply in India in 2021-22

The current chapter provides details of the supply of various energy products in India. There is sufficient and periodic data available for the supply of energy products like coal, oil and oil products, natural gas, electricity and etc. However, the supply of some energy products could not be captured in the report due to the unavailability of such data and/or supply estimates. Inclusion of supply estimates of biomass and various biofuels like compressed biogas, waste to energy, etc. can make India's energy data more detailed and robust.

* Refer to Annexure IV for the physical values of Figure 12

Chapter 4: Demand Side Analysis: Sectoral Energy Usage

Similar to energy supply, understanding of energy demand across different end-use sectors is vital for energy planning and policy formulation of a country. Insights into growth and pattern of energy consumption in different sectors helps policymakers, academicians and researchers in understanding behavioral patterns, structure of everyday life and how energy demand has varied over time.

The following sections discuss energy consumption of various end use sectors, namely industries, transport, building and agriculture (as classified in Table 4 of Chapter 2) in details.

4.1 Industry

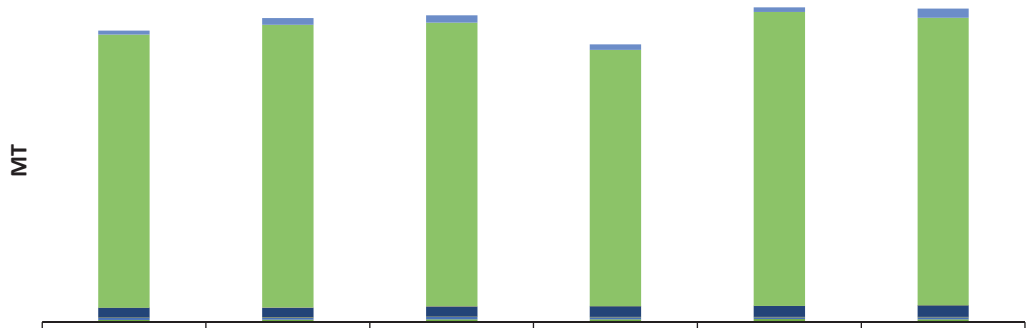
The industrial sector accounted for 56% of India's total energy consumption in 2021-22 and contributed to 26% to India's GDP in 2021 (*India - Distribution of Gross Domestic Product (GDP) across Economic Sectors 2021, 2023*).

Energy intensity of Indian manufacturing industries is among the highest in the world (Soni et al., 2017). Understanding energy consumption patterns of hard to abate sectors like Iron and Steel, Cement, petrochemicals, etc in India can facilitate in the development of suitable policies for energy efficiency and decarbonisation.

Industry sector in India is highly dependent on coal. Coking coal is used as an input in manufacturing of steel, while non-coking coal is used for electricity production and thermal uses in industry. Natural gas, on the other hand is used as feedstock in chemical, fertilizer production. Petroleum products find their use in industries for heating purposes, solvent in paints and chemicals, for building purposes and as feedstock.

Figure 13 present that consumption of various energy products in Industry in India. It can be seen from Figure 13, Coal is the highest consumed energy product in Industry sector, followed by Naphtha. Consumption of LSHS has witnessed the fastest growth of 30% followed by lignite at 19% CAGR.

Table 10 presents information on natural gas consumption, while Figure 14 depicts trends in electricity consumption in the Industry sector in India.



	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Lignite	4.3	7.5	7.9	5.9	5.3	10.3
Coal	302.2	313.0	314.1	283.8	325.1	318.2
Kerosene	0.1	0.1	0.1	0.1	0.1	0.1
Naptha	10.8	10.8	11.4	11.9	12.3	12.7
LPG	0.2	0.2	0.2	0.2	0.2	0.2
LSHS	0.1	0.1	0.2	0.2	0.2	0.2
Furnace Oil	2.6	2.4	2.6	2.2	2.0	2.2
Diesel	2.3	2.6	2.9	3.0	3.3	3.1

Year

Figure 13: Consumption of Various Energy Products in Industry sector from 2016-17 to 2021-22, in MT

Source: Coal Directory, 2020-21 and IPNG Statistics, 2021-22

Table 10: Natural Gas Consumption in Industry Sector from 2016-17 to 2021-22 (MMSCM)

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Natural Gas (in MMSCM)	21278	20977	20583	20952	22055	22906

Source: IPNG Statistics, 2021-22

Natural gas consumption dipped in 2017-18 till 2019-20, however consumption picked up in 2020-21 and 2021-22.

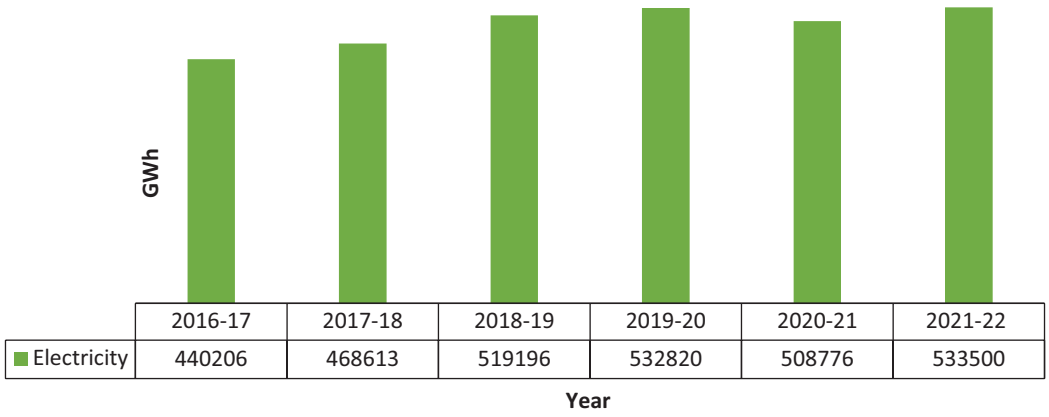


Figure 14: Electricity consumption in Industry Sector from 2016-17 to 2021-22, in GWh

Source: General Review, 2021

From the Figure 14 it can be seen that consumption of electricity enhanced till 2019-20, however there was a dip in consumption in 2020-21 due to COVID-19. Consumption of electricity again picked up in 2021-22.

While there has not been much increase in natural gas consumption, electricity consumption has increased by 4 % CAGR from 2016-17 to 2021-22.

To get a better understanding of the energy consumption of industry sector, it is imperative to dig deeper into various industries and get insights into their energy consumption profiles.

4.1.1 Iron and Steel

The Iron and Steel sector usually produces pig iron, sponge iron and finished steel. India's per capita steel consumption was 70 kg in 2020-21. This is one-third of the global average of 227.5 kg. The iron and steel sector accounts for 20% of total industrial energy-use, making it the largest energy-consumingsub-sector. Major sources of energy used in Iron and Steel sector are coal and electricity. Coking coal ormetallurgical coal is used in manufacturing steel. Coking coal is heated in the absence of air to producecoke, a hard porous material which is used in blast furnaces to reduce the iron ore to pig iron. Non cokingcoal is used in captive power plants to produce electricity.

Table 11 shows the share of coal and lignite in total energy consumption of iron and steel sector. Table 12 depicts the consumption of petroleum products in the iron and steel sector. It can be seen that coal consumption in iron and steel sector has been increasing in the last six years.

Coal consumption in the iron and steel industry has increased by 5% CAGR, however consumption of LSHS has witnessed the fastest growth of 14% CAGR from 2016-17 to 2021-22.

Table 11: Coal and Lignite Consumption in Iron and Steel Sector from 2016-17 to 2020-21, in MT

	2016-17	2017-18	2018-19	2019-20	2020-21
Coal	57.5	67.0	65.0	74.2	70
Lignite	0.07	0.2	0.1	0.01	0.03

Source: Provisional Coal Statistics, 2020-21, Energy Statistics, 2023

Table 12: Petroleum Product Consumption in Iron and Steel Sector from 2016-17 to 2021-22, in MT

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Diesel	0.2	0.2	0.1	0.1	0.1	0.1
Low Sulphur Heavy Stock	0.05	0.04	0.07	0.09	0.09	0.09

Source: IPNG Statistics, 2022

Since iron and steel is an energy intensive sector, the Ministry of Steel has committed to achieve net zero target by 2070. This is strategized through promotion of energy and resource efficiency, renewable energy in the short term (2030), Green Hydrogen and Carbon Capture, Utilization and Storage in the medium term (2030-2047) and disruptive alternative technological innovations to help achieve the transition to net-zero in the long run (2047-2070) in the iron and steel sector.

Several other policies are being promoted by the Indian Government to decarbonize the steel sector and ensure resource efficiency and circular economy in this sector. Steel Scrap Recycling Policy, 2019 aims to enhance the availability of domestically produced scrap to reduce the consumption of coal in steel making. Further, the Motor Vehicles (Registration and Functions of Vehicles Scrapping Facility) Rules September 2021 will increase the availability of scrap for the steel sector. Along with these policies, National Green Hydrogen Mission and National Solar Mission (by Ministry of New and Renewable Energy) will play a vital role in transitioning towards cleaner fuels in the steel sector (ETEnergyworld, 2023).

4.1.2 Pulp and Paper

Pulp and paper is an energy intensive sector. This industry uses wood, bamboo, recyclable waste paper, and agro-residues such as bagasse, wheat straw, and rice husk as raw materials[5]. Kraft pulping is the most common chemical pulping process. Indian paper industry accounts for almost 3.7% of world's paper production. Pulp and paper industry uses non-coking coal for electricity production in captive power plants.

[5] The paper and pulp industry uses biomass in its production process, primarily for pulp production, electricity generation and byproduct generation. However due to unavailability of data on aggregate level on quantity of biomass consumption in the paper and pulp industry, this data is not included in the report.

Table 13 represents coal and lignite consumption in Paper and Pulp Industry.

Table 13: Coal and Lignite Consumption in Paper and Pulp Industry a from 2016-17 to 2021-22, in MT

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Coal	1.1	1.5	2.0	1.3	1.0	1.2
Lignite	0.5	0.7	0.6	0.5	0.5	0.7

Source: Provisional Coal Statistics, 2020-21, Energy Statistics, 2023

Coal consumption in the paper and pulp industry has increased by CAGR 2%, while lignite consumption has increased by 7% CAGR. The pulp and paper industry has been identified as one of the most energy intensive industry, therefore it is included in the PAT Scheme of BEE.

4.1.3 Textile

Energy has a major cost component in the textile industry. The major energy-intensive processes in the production of textiles are spinning, weaving, wet-processing (dyeing and printing), and synthetic fiber production. Electricity is the major form of energy consumed in this sector, which is largely used in running spinning machines, dehumidification, lighting, and air compressors. Wet processing or dyeing operations consume almost 50% of the energy in a composite mill. Thermal energy (steam and hot water) is primarily used to process, dye, print, and dry the cloth during wet processing. There is large scope to save energy in boilers, steam distribution, and drying operations in a textile mill.

Table 14 presents coal and lignite consumption in Textile Sector. There was a 20% and 23% CAGR decline in coal and lignite consumption from 2016-17 to 2021-22 respectively.

Table 14: Coal and Lignite Consumption in Textile Sector from 2016-17 to 2021-22, in MT

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Coal	0.24	0.24	0.20	0.10	0.08	0.08
Lignite	1.29	2.46	2.61	0.16	0.29	0.34

Source: Provisional Coal Statistics, 2020-21, Energy Statistics, 2023

4.1.4 Petrochemical

Petrochemicals are chemicals derived from petroleum or natural gas and are an essential part of the chemical industry. They provide a vital link between natural resources and value-added products. Petrochemical industry mainly comprise of synthetic fiber/ yarn, polymer, synthetic rubber, plastics and etc.

Energy in petrochemical industry is used in three different forms in a petrochemical plant, namely: (i) fuel (ii) steam, and (iii) electricity. Table 15 and Table 16 represent oil product and coal consumption in Petrochemical Sector respectively. Of all the energy products consumed in the petrochemical industry, only Naphtha and diesel consumption have witnessed a growth. While diesel consumption has increased by 2%, Naphtha consumption has increased by 3% CAGR.

Table 15: Petroleum Products consumption in Petrochemical Sector from 2016-17 to 2021-22, in MT

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Diesel	0.1	0.1	0.1	0.1	0.1	0.1
Furnace Oil	0.2	0.2	0.2	0.2	0.2	0.2
Naphtha	10.2	10.0	10.6	10.8	11.3	12.0

*Source: IPNG Statistics, 2022**

Table 16: Coal and Lignite consumption in the Petrochemical Sector from 2016-17 to 2020-21, in MT

	2016-17	2017-18	2018-19	2019-20	2020-21
Coal	0.3	0.2	0.2	0.2	0.1
Lignite	0.1	0.2	0.3	0.2	0.3

Source: Provisional Coal Statistics, 2020-21, Energy Statistics, 2023[7]

4.1.5 Aluminum

Aluminum is an energy intensive industry. Its main production process includes refining of alumina from bauxite ore, anode production, electrolytic smelting of alumina to aluminum, and re-melting of aluminum for conversion to rolled, extruded, and casted products. In the aluminum industry, aluminum smelting is the most energy intensive process. Production of aluminum consumes about 36 kilowatt hour per kilogram (kWh/kg) of electricity and of this about 40% or 15 kWh/kg is consumed during aluminum smelting. The specific energy consumption (SEC) of Indian aluminum smelters is in the range of 14,400-18,000 kWh/T (TEDDY 2021-22, 2023)[6]. Figure 15 presents diesel and furnace oil consumption in Aluminum Sector.

Consumption of furnace oil has increased by 9% CAGR, while consumption of diesel has shown a small decrease from 2016-17 to 2021-22.

[6] Electricity is the main source of energy in the aluminum industry. However data on electricity consumption by industries could not be captured due to unavailability.

[7] Refer to Annexure VII for data on Non Energy use of energy products in Petrochemical industry.

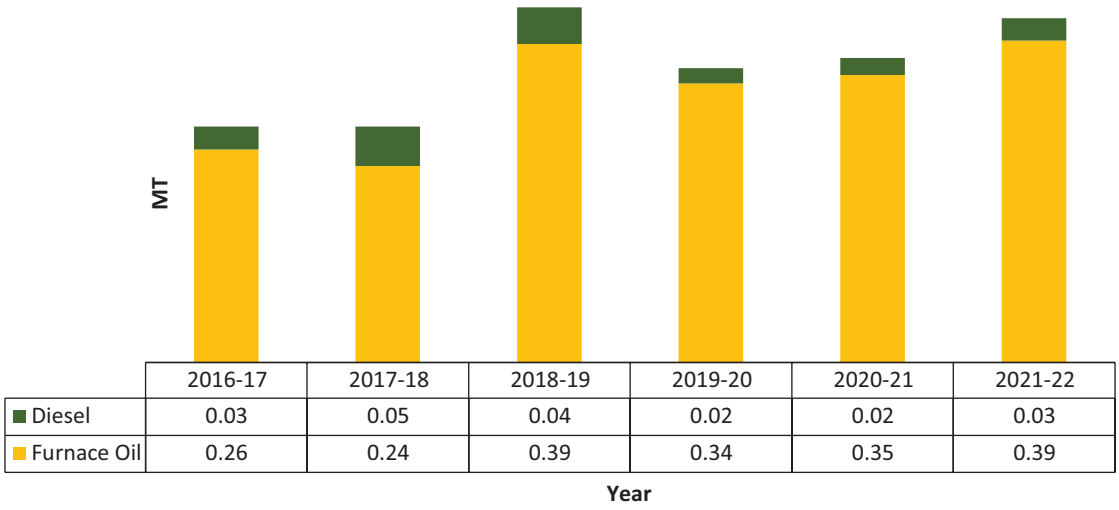


Figure 15: Consumption of Diesel and Furnace Oil in Aluminum Sector in India, from 2016-17 to 2021-22, in MT

Source: IPNG Statistics, 2022

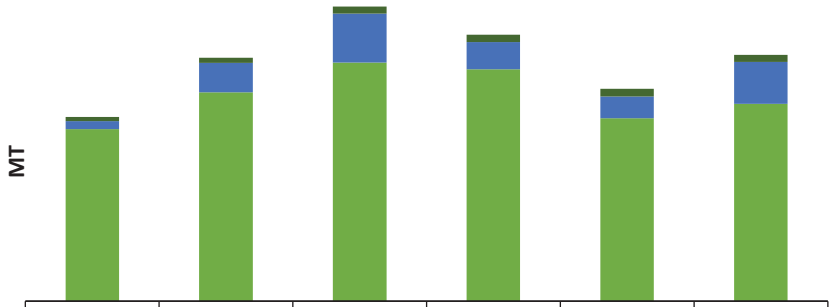
A coalition of six Indian industry majors including aluminum giants like Hindalco and Vedanta have signed 'Industry Charter for Near-Zero Emission by 2050". Initiatives to decarbonize these industries will include adoption of energy efficiency, renewable energy, circular economy across member companies and supply chains; support to achieve absolute carbon emissions reduction; undertake carbon confinement efforts, create synergies to build market and policy perspectives on decarbonisation; set reporting indicators and voluntary targets to enable tracking of corporate goals on decarbonisation pathway, and create excitement and vigour among peers through documentation and wide outreach of best practices, technology or business models towards decarbonisation.

4.1.6 Cement

Cement industry is one of the highest energy consuming industrial sub-sector. It contributes to about 8% of India's GHG emissions (www.ETEnergyworld.com, 2023). Ordinary Portland Cement (OPC), Portland Pozzolana Cement (PPC), Portland Blast Furnace Slag Cement (PBFSC), and others including white and specialized cement are some of the products of the cement industry. Clinkerization is the most energy intensive process in the production of cement. This process uses energy from coal (thermal energy). Grinding of clinker consumes the maximum amount of electrical energy. The industry's average energy consumption is estimated to be about 725 kilocalories per kilogram (kcal/kg) (thermal energy) for clinker production and 80 kilowatt hour/tonne (kWh/T) (electrical energy) for cement production.

Carbon intensity in cement industry can be reduced by improving thermal efficiency in the kiln, fuel switching, electrification of cement kilns, and carbon capture and sequestration (CCS). Of all these options, thermal efficiency measures are already being implemented.

Figure 16 presents consumption of various energy products in Cement Sector. While coal is the highest consumed energy product in cement sector, lignite consumption has witnessed the highest growth of 40% CAGR from 2016-17 to 2021-22, followed by furnace oil and diesel[8].



	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Diesel	0.2	0.2	0.3	0.3	0.3	0.3
Lignite	0.3	1.1	1.8	1.0	0.8	1.6
Coal	6.4	7.7	8.8	8.6	6.8	7.3

Year

Figure 16: Consumption of Various Energy Products in Cement Sector in India, from 2016-17 to 2021-22, in MT

Source: IPNG Statistics, 2022, Provisional Coal Statistics, 2020-21, Energy Statistics, 2023

4.1.7 Chlor-Alkali

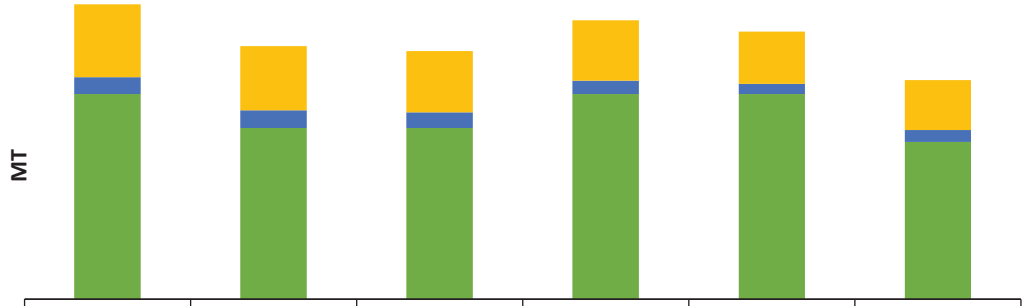
Electrolysis of brine (NaCl) is an energy intensive process in the Chlor-alkali industry. Main products of the industry are chemicals such as caustic soda (sodium hydroxide), soda ash (sodium carbonate), and chlorine, while electrolisation is the most energy intensive process in the chlor-alkali industry. Electricity is the main energy used in this industry. Caustic soda manufacturing is highly energy intensive; the process consumes about 2.5 megawatt (MW) per tonne of electricity (TEDDY). The mercury cell process is the most energy intensive, and consumes about 3.7 MWh of electricity per metric tonne of chlorine; the diaphragm cell process consumes about 2.9 MWh/T; and the membrane cell process is the cleanest and most energy efficient at 2.5 MWh/T.

4.18 Fertilizer Industry

Manufacturing of ammonia–urea is the most energy-intensive segment in fertilizer industry. It accounts for about 85% of the total energy consumption in the sector. Natural gas is a common feedstock used

[8] Cement industry uses petcoke to produce energy in cement kilns and also as a raw material (for non-energy purpose) for blended cements. Data on petcoke consumption by cement industry could not be captured due to unavailability.

in the manufacture of urea, followed by naphtha. The manufacture of ammonia accounts for 80% of the energy required for urea production. Replacing natural gas as a feedstock for ammonia production with green hydrogen offers a potential to produce green fertilizer. According to WRI if 19.1 MTPA ammonia production in India transitions to green hydrogen, emissions of up to 30.6 MTPA can be averted across the country (Nallapaneni, & Sood, 2022). Figure 17 present information on consumption of various energy products in fertilizer sector in India. All the fuels show a declining consumption trend ranging between 5-7% CAGR in the fertilizer industry[9].



	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Coal	2.1	1.9	1.8	1.8	1.5	1.5
Furnace Oil	0.5	0.5	0.5	0.4	0.3	0.3
HSD	0.01	0.01	0.01	0.01	0.01	0

Figure 17: Consumption of Various Energy Products in Fertilizer Sector in India from 2016-17 to 2021-22, in MT

Source: Provisional Coal Statistics, 2020-21 and IPNG Statistics, 2022

4.2 Transport

India's motorised passenger travel demand has mostly been fulfilled by road, rail and a small share by air travel. There is a rise in ownership of vehicles due to rising income levels. Transport sector consumes LPG, Diesel, Petrol and Diesel. Transport sector accounts for almost 19% of total energy consumption in India.

Figure 18 presents oil product consumption in India from 2016-17 to 2021-22, while Table 17 shows electricity consumption in transport sector. Figure 18 presents the consumption of petrol that has increased by 5% CAGR where as a the consumption of diesel has increased in 2019 and declined in 2020-21.[10]

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[9] Refer to Annexure VIII for data on Non Energy use of energy products in fertilizer industry.

[10] Data on CNG use in transport is not captured due to unavailability.

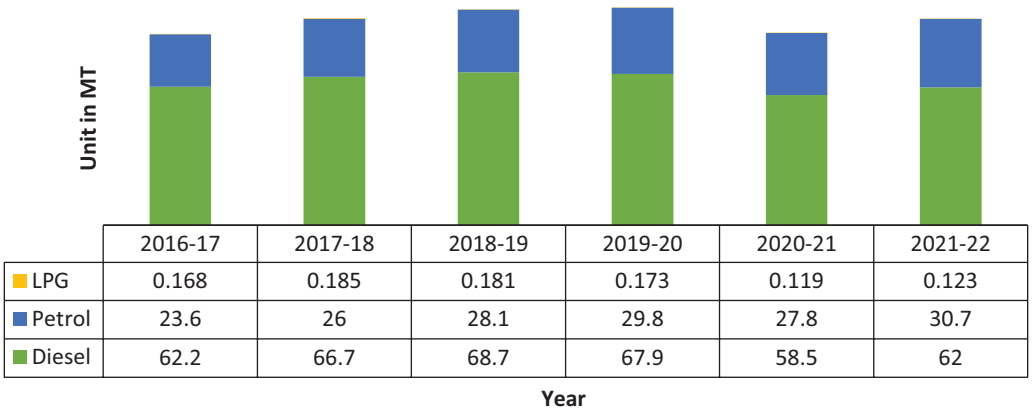


Figure 18: Oil Product Consumption in Transport Sector2016-17 to 2021-22, in MT

Source: IPNG Statistics, 2022

Table 17: Electricity Consumption in Transport Sector from 2016-17 to 2021-22, in GWh

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Electricity	15683	17433	18837	19148	14668	19800

Source: General Review, CEA,(2016-17 to 2021-22)

Disclaimer: The data will be refined in the next annual version of the EDMU report

4.3 Building

4.3.1 Household

Energy in the household sector is primarily consumed for lighting, cooking, refrigeration, space cooling, communication and other electrical appliances. The most common energy sources at the household level include electricity, LPG, solid biomass, biogas, and kerosene.[11]

Electricity and LPG are the main energy sources consumed in India. Due to the size of population and rapid urbanization, there has been an increase in the electricity consumption in the residential sector. The per capita consumption of electricity rose from 1208 KWh in 2019-20 to 1255 kWh in 2020-21(TEDDY 2021-22, 2023). Government policy of 'Power for All' aims to provide each household access to electricity, round the clock.

On cooking energy, the government's policy UJWALA scheme ensures providing women with clean cooking fuel – LPG.

[11] Data on biomass and kerosene consumption in the household sector could not be captured due to unavailability.

Table 18 represents electricity consumption[12] in the household sector.

It can be seen that electricity consumption and LPG consumption has been increasing in the household sector from FY 2016-17 to FY 2021-22.

Table 18: Electricity Consumption in Household Sector 2016-17 to 2021-22, in GWh

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Electricity	255826	273545	288243	308745	330809	334000

Source: General Review, CEA, (2016-17 to 2021-22)

Figure 19 represents LPG and Kerosene consumption in the household sector.

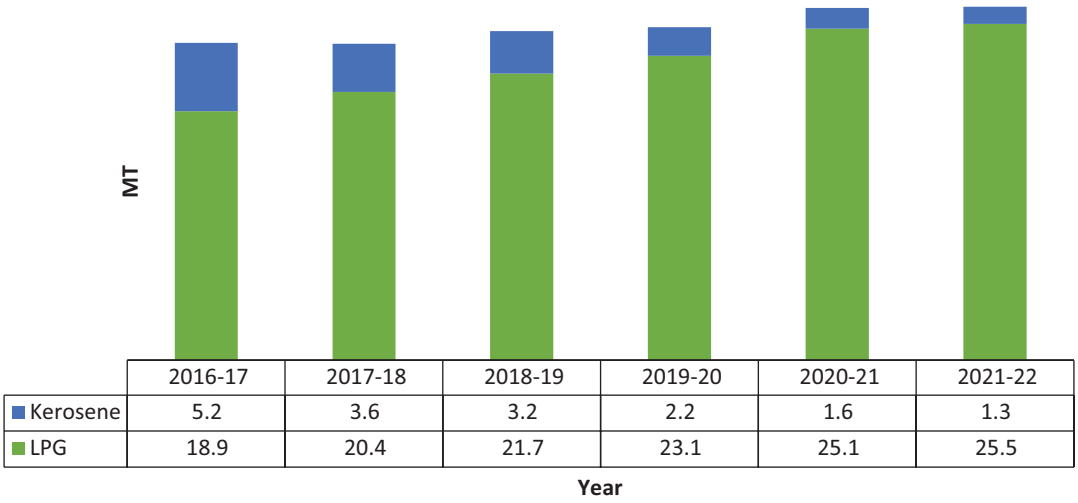


Figure 19: LPG and Kerosene Consumption in Household Sector from 2016-17 to 2021-22, in MT

Source: IPNG Statistics, 2022

The electricity consumption and LPG consumption in the household sector as shown in the figure below has increased by 5% and 6% CAGR respectively, while kerosene consumption has reduced by 24% CAGR. This clearly indicates the shift of cooking practice of households from kerosene to LPG. This is also due to the effect of household electrification as kerosene was mainly used for lighting by non electrified households.

Electricity is usually consumed in the household by electrical appliances. Although data on production of appliances is available, the specific energy consumption of individual electrical appliances is not being captured. Table 19 presents yearwise production of electrical appliances.

[12] Electricity consumption in households is majorly due to cooling, lighting and heating purposes. Detailed information on electricity consumption for the above mentioned purposes can be collected. However this data is not covered in the report presently.

Table 19: Production Figure for Appliances 2017-18 to 2021-22

S. No	Appliance	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-22	Total (in Million)
			Mandatory Appliance				
1	Frost Free Refrigerator	2,578,277	2,861,285	3,074,275	3,017,997	3,334,463	12.29
2	TFL	81,219,925	63,187,569	52,775,743	48,189,268	28,515,378	192.67
3	Room Air Conditioner (Fixed Speed)	5,384,058	3,304,280	3,797,043	2,511,348	2,543,997	12.16
4	Direct Cool Refrigerator	10,014,626	11,067,110	11,998,899	9,732,127	9,619,339	42.42
5	Distribution Transformer	347,515	500,544	464,389	338,115	355,950	1.66
6	Color Television	9,479,658	9,298,819	8,703,395	8,335,140	7,789,678	34.13
7	Stationary Type Water Heater	2,741,279	3,287,462	3,736,438	3,800,519	4,476,931	15.29
8	Room Air Conditioner-(Variable Speed)	2,267,364	3,924,884	5,050,951	4,113,958	5,749,914	18.84
9	LED LAMPS	27,290,510	243,974,600	505,633,490	465,096,423	473,775,891	1,688.48
Total (in Million)		**141.32**	**341.40**	**595.23**	**545.13**	**536.15**	**2,017.93**

4.3.2 Commercial

Commercial energy use includes the consumption of the service sector. It is highly correlated to population growth (as services tend to population serving). Commercial energy use is driven by electrical, heating, and cooling of buildings and other structures, though traffic lights, water, and sewer systems are also included in this category. Table 20 and Table 21present electricity and LPG consumption in commercial sector.

While LPG consumption has remained almost the same in commercial sector from 2016-17 to 2021-22, electricity consumption has increased 36% CAGR from 2016-17 to 2021-22.

TABLE 20: Consumption of Electricity in Commercial Sector in India from 2016-17 to 2021-22, in GWh

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Electricity	89825	93755	98228	106047	86950	107500

Source: General Review, CEA, (2016-17 to 2021-22)

TABLE 21: LPG Consumption in LPG in Commercial Sector in India from 2016-17 to 2021-22, in MT

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
LPG	1.8	2.1	2.4	2.6	1.9	2.2

Source: IPNG Statistics, 2022

Several initiatives are being undertaken by the government on improving energy efficiency in the building sector. Standard and Labelling in appliances, Energy Conservation Building Codes (ECBC), Bachat Lamp Yojana (BLY), Super-Efficient Equipment Programme (SEEP), UJJWALA Yojana are some of the initiatives that will help in reduction of energy consumption in building sector.

4.4 Agriculture

Agriculture in India provides employment to almost 46.5% of Indian workforce which contribute to about 20% to the country's GDP. Understanding the energy requirements of agriculture sector is vital for ensuring energy and food security of the country.

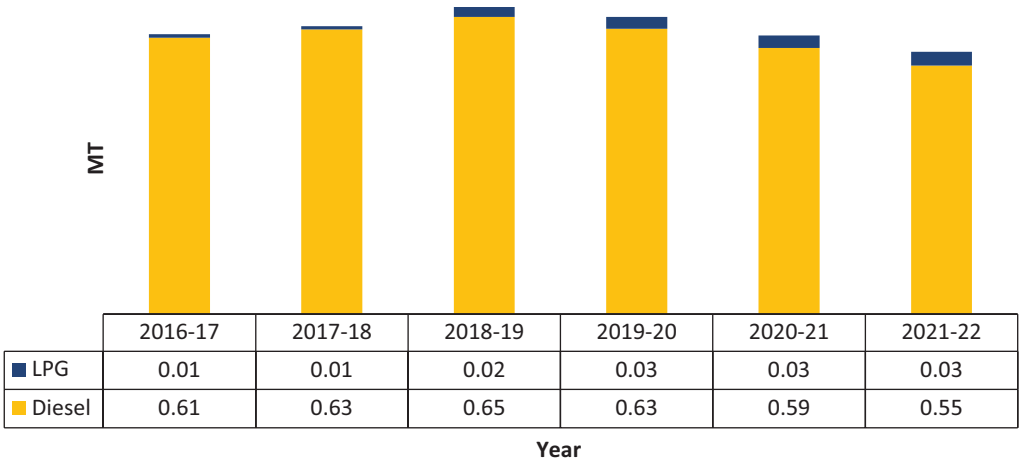
Crop production has emerged as one of the major consumers of energy in India. Energy needs in agriculture sector includes energy required for land preparation, cultivation, irrigation, harvesting, post-harvest processing, food production, storage and the transport of agricultural inputs and outputs (*Energy for Agriculture*). Diesel is used to run tractors and tube-wells, while Light Diesel Oil is used in agriculture pumps sets. Mechanization of agriculture is pushing up demand for diesel and electricity in agriculture sector.

LPG, on the other hand, is used for protecting and drying grains and for heating/ temperature control in nurseries.

Figure 20 and Figure 21 present LPG, diesel and electricity consumption in the agriculture sector. It can be seen in the graphs below, that diesel is the highest consumed fuel in agriculture sector.

Diesel consumption has fallen by 2% CAGR from 2016-17 to 2021-22, while LPG consumption has increased by a CAGR of 30% over years.

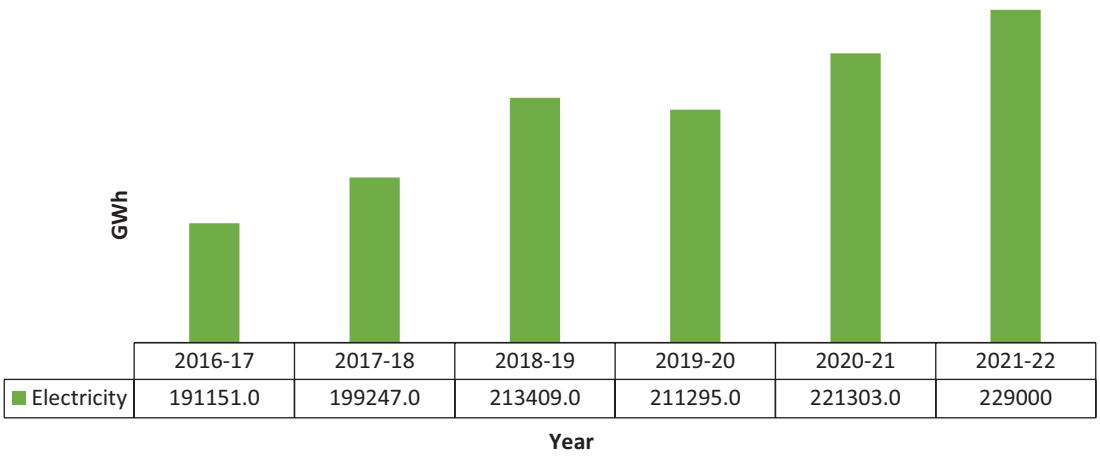
Electricity consumption increased till 2018-19 but fell in 2019-20 to finally increase till 2021-22. Overall there has been an increase of 36% CAGR in electricity consumption in agriculture sector.



	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
LPG	0.01	0.01	0.02	0.03	0.03	0.03
Diesel	0.61	0.63	0.65	0.63	0.59	0.55

Figure 20: LPG and Diesel consumption in Agriculture Sector from 2016-17 to 2021-22, in MT

Source: IPNG Statistics, 2022



	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Electricity	191151.0	199247.0	213409.0	211295.0	221303.0	229000

Figure 21: Electricity Consumption of the Agriculture Sector in India from 2016-17 to 2021-22, in GWh

Source: General Review, CEA, (2016-17 to 2021-22)

The agricultural sector is the central point of the climate–water–land–energy–food nexus debate. Development of sustainable agriculture sector would ensure food for the rising world population while reducing the environmental impact and preserving the most important natural resources for future generations (Streimikiene, 2021). Oil Products and electricity consumption result is increased farm output, however there is a scope for replacing fossil fuel-based energy by renewable energy in agriculture. Government of India schemes like KUSUM (Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan), PM Krishi Sinchai Yojana, National Mission for Sustainable Agriculture, Agricultural Demand Side Management Programmes for energy efficiency, etc. can go a long way in ensuring food security and making our agriculture sustainable.

Conclusion

Based on the discussion in the previous sections, Figure 22 presents the energy product consumption of various end-use sectors. In Figure 22, quantity of energy products consumed in each sector have been converted to energy terms (in ktoe) to understand the share of each energy product consumed in every sector.

Along with the sectors mentioned above, two more sectors have been added in the Figure 22, namely Power and Miscellaneous. Power sector is not an endues sector, rather it transform energy products into electricity. This sector is a major consumer of coal in India, therefore it is included in this analysis.

For a lot of energy products, end-use consumer of some part of their production is not known, therefore the miscellaneous sector includes all those consumptions whose actual use sector in not known.

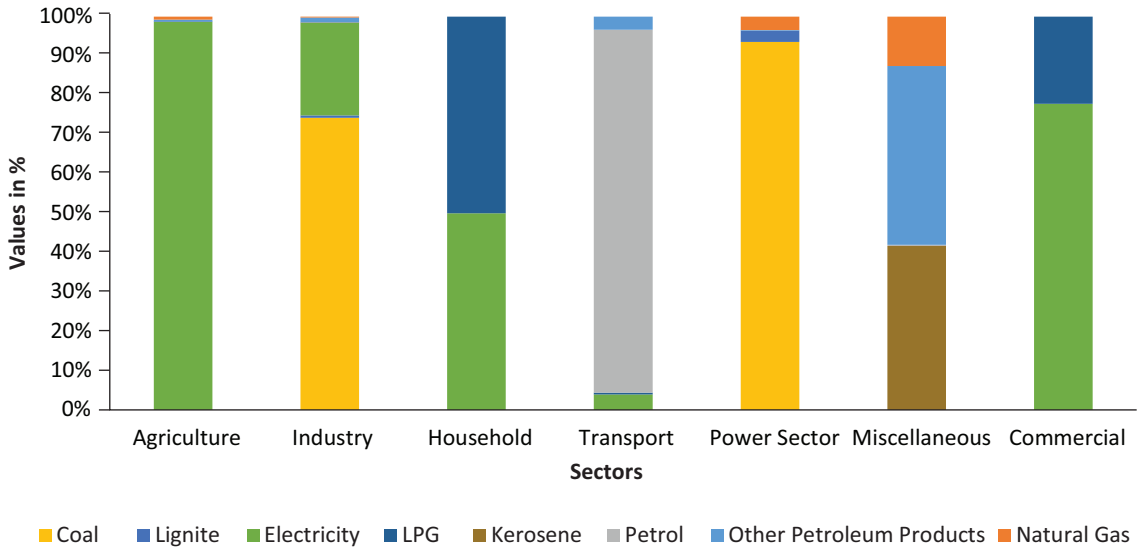


Figure 22: Energy Product consumption pattern of Various Consuming Sector in % in 2021-22

It can be seen from the Figure 22 that electricity is the most important energy source in the agriculture and commercial sector. In industry almost 60% of the energy consumed is derived from coal[13]. For household electricity and LPG are consumed for lighting and cooking purposes, while in transport sector, almost 90% of the energy is derived from petrol. Coal is the most important energy product for power sector.

In the demand side of energy reporting, there is scope for collecting granular level data on energy consumption (in the form of different product-wise/fuel wise consumption). Such kind of granularity in data collection will help in monitoring the policy implementation related to adoption of energy efficient technologies and use of cleaner fuels by different sectors.

The chapter has been able to provide details of consumption of energy products like coal, oil and oil products, natural gas, and electricity (to some extent). However, consumption of biomass, electricity in various industries is not included in the report due to non-availability of data.

Energy products in the household and commercial sector is used for various purposes like heating, lighting, and cooking. This bifurcation of use of energy products for the above-mentioned purposes is not yet available.

Data of electricity consumption in the transport sector can help track the penetration of electric vehicles in the country.

Inclusion of such estimates can make India's energy data more detailed and robust.

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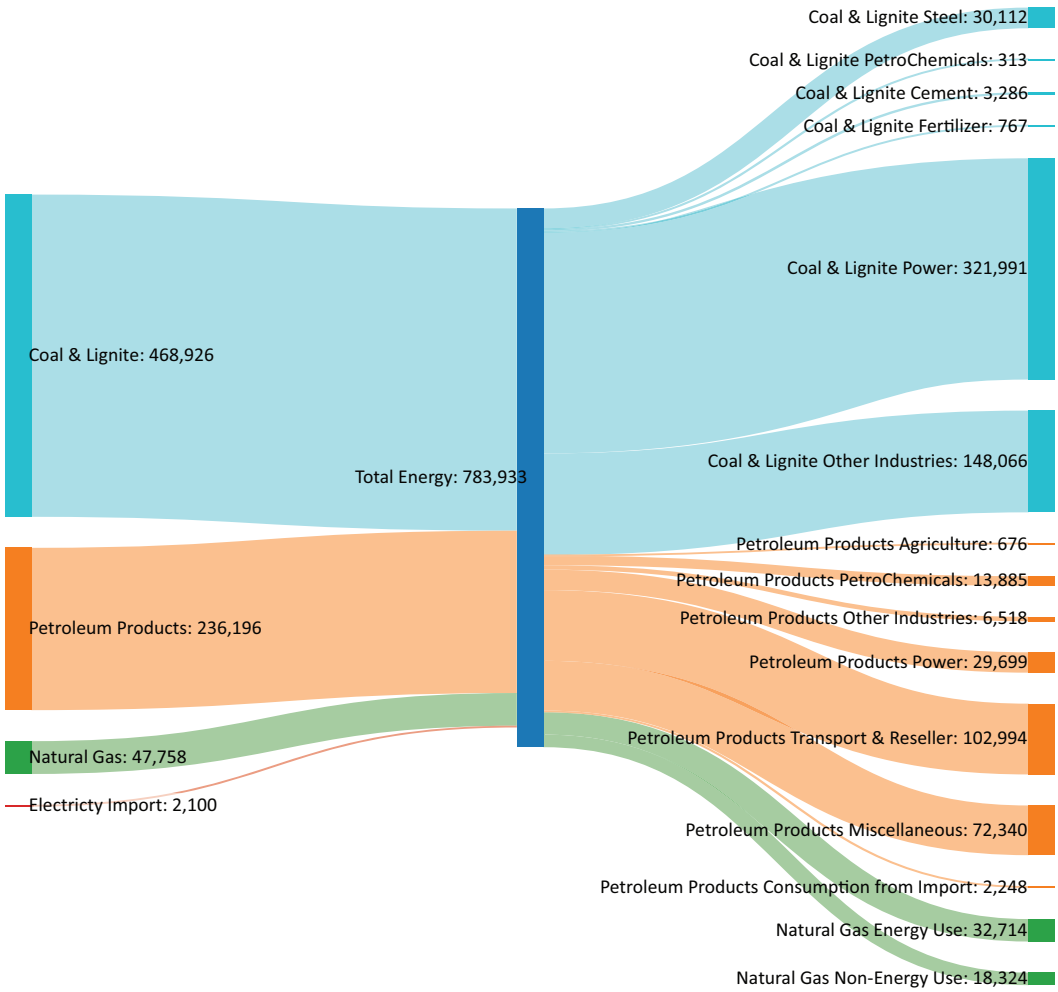
[13] Electricity consumption by different industries could not be captured due to unavailability. EDMU will try to include that information in its upcoming publications.

[14] Share of kerosene consumption is very small in the household sector, therefore the share is very small in Figure 22

Chapter 5: Energy Supply and Demand Trend Analysis

5.1 Sankey Diagram for Energy Balance

Sankey diagram for energy balance is a graphical representation of flow of energy products where they can be combined, split and traced through a sequence of stages. The width of each stream represents the amount of energy in the flow. Sankey diagrams are typically used to visualize energy transfer between various processes. Figure 23 shows the supply of various energy products in India and its consumption in various intermediate, end use sectors and subsectors.



Figire 23: Sankey Diagram of Overall Energy Flow in India during 2021-22, in Mtoe

All energy products supplied and consumed in the domestic territory are measured in terms of quantity units (as discussed in Chapter 3 and 4). However to make energy data comparable, it needs to be converted into a common unit, i.e., in energy terms.

The present chapter discusses supply and consumption of various energy products in energy units.

5.2 Supply Side Data of Energy Products

Table 22 presents the supply of various energy products in India from 2016-17 to 2021-22 in energy terms (in ktoe).

From the table it can be seen that there has been moderate increase in the supply of energy derived from most energy products. Highest growth in energy derived is seen in from fuel oil while there is decrease of 21% CAGR in energy derived from Kerosene.

In terms of share, India derives almost 61% of its energy from coal, followed by diesel with a share of approximately 12%.

Table 22: Net Supply of Various Energy Products in India from 2016-17 to 2021-22, in ktoe

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Total Coal	400,852	415,777	454,010	462,963	432,016	457,992
Lignite	10405.2	10730.4	10171.2	9673.1	8677.9	10934.2
Naphtha	15,815	14,992	16,843	15,192	15,925	16,273
ATF	7,381	8,251	8,933	8,985	3,796	5,466
Diesel	79,351	82,895	86,796	85,888	73,735	78,296
Lubes	3,157	3,573	3,409	3,611	3,759	4,283
Fuel Oil	8,509	8,051	9,115	11,490	12,331	15,400
Bitumen	5,680	5,741	6,201	6,380	6,793	7,213
Petcoke	20,482	19,958	15,894	19,045	15,047	15,584
Kerosene	6,297	4,589	4,235	3,173	2,485	1,988
Paraffin Wax	81	99	86	92	93	96
Petrol	22,689	25,058	27,070	29,407	26,745	28,748
Other Petroleum Products	20,476	24,269	29,896	28,818	29,873	30,254
Natural Gas	42,253	44,472	45,456	47,275	44,714	47,758
LPG	24,991	26,443	28,933	30,711	31,748	32,595
Electricity Import	771	1,004	1,657	2,036	1,832	2,101
Total Supply	**669,193**	**695,902**	**748,764**	**764,739**	**709,570**	**754,981**

5.3 Consumption Side Data of Energy Products

Table 23 presents coal consumption in various sectors in India from 2016-17 to 2021-22. Power sector is the largest consumer of coal in India. In 2016-17, 60% of total coal was consumed by power sector. This

share increased to 65% in 2021-22. Industry consume 40% of total coal in 2016-17, which decreased to 35% in 2021-22.

There is a 4% CAGR increase in total coal consumption. Industry consumption of coal has remained almost same from 2016-17 to 2021-22, while power sector consumption of coal has increased by 6% CAGR during the same period.

NOTE 1: Imports of energy products have been considered as a part of energy consumption due to the unavailability of data regarding the end use of imports.

NOTE 2: Consumption of energy products for a particular year includes the previous year's stock.

Table 23: Coal Consumption by Various Sectors in India from 2016-17 to 2021-22, in ktoe

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Industry	153,837	159,462	162,683	152,312	165,974	170897.0
Iron and Steel	29,990	34,474	33,980	37,936	36,414	29,755
PetroChemicals	133	115	102	86	64	313
Cement	2,705	3,188	3,637	3,506	2,727	2,929
Textile	103	98	84	41	32	33
Fertilizer	909	779	738	722	617	587
Paper	503	625	744	543	422	502
Others Industries	119,494	120,184	123,397	109,479	125,698	136,778
Power Sector	234,208	256,287	275,559	274,086	251,579	310,703
Total	**388,045**	**415,749**	**438,242**	**426,398**	**417,552**	**481,600**

Table 24 presents lignite consumption in various sector. Consumption of lignite in industry has increased from 10% to 21% from 2016-17 to 2021-22 of total lignite consumption. There is overall growth of 3% CAGR in lignite consumption in India from 2016-17 to 2021-22. However lignite consumption in lignite has increased by 19% CAGR from 2016-17 to 2021-22.

Table 24: Lignite Consumption by Various Sectors in India from 2016-17 to 2021-22, in ktoe

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Industry	996	1,720	1,815	1,362	1,281	2,374
Iron and Steel	17	49	33	0	9	357
PetroChemicals	45	51	75	69	84	-
Cement	67	251	415	229	187	357
Textile	297	565	601	37	67	782
Paper	121	174	138	126	130	180
Others Industries	449	629	553	901	805	1,056
Power Sector	8,930	8,933	8,677	8,356	7,576	8,915
Total	**9,926**	**10,653**	**10,493**	**9,718**	**8,856**	**11,288**

Table 25 presents LSHS consumption in various sectors in India. Industry is the major consumer of LSHS in India. It consumes almost 50% of total LSHS consumption in India. Industry LSHS has increased by 34% CAGR from 2016- 17 to 2021-22.

Table 25: LSHS Consumption in Various Sectors in India from 2016-17 to 2021-22, in ktoe

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Agriculture	-	1	8	7	7	7
Industry	54	57	185	214	208	202
Iron and Steel	49	40	76	91	99	94
PetroChemicals	4	6	14	13	11	7
Cement	-	0	1	1	1	1
Textile	-	0	3	3	4	7
Fertilizer	1	1	1	1	1	1
Others Industries	-	10	90	105	92	94
Power Sector	17	-	10	19	11	31
Miscellaneous	39	65	187	173	174	232
Total	**110**	**123**	**391**	**412**	**400**	**470**

Table 26 presents consumption of ATF in various sectors in India. There is an overall decrease of 6% in ATF consumption from 2016-17 to 2021-22.

Table 26: ATF Consumption in Various Sectors in India from 2016-17 to 2021-22, in ktoe

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Foreign airlines	1,534	1,631	1,943	1,983	785	1,064
Indian airlines	4,620	5,103	6,651	6,566	3,162	4,282
Imports	362	321	277	-	1	1
Others	973	1,113	12	9	8	12
Total	**7,489**	**8,168**	**8,883**	**8,558**	**3,956**	**5,359**

Table 27 presents diesel consumption in various sectors in India. The largest share of diesel is consumed by transport sector. Energy derived from diesel has remained almost constant from 2016-17 to 2021-22.

Table 27: Diesel Consumption by Various Sectors in India from 2016-17 to 2021-22, in ktoe

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Agriculture	630	649	678	650	607	567
Industry	2,362	2,655	3,035	3,156	3,433	3,248
Iron and Steel	165	158	153	140	130	141
PetroChemicals	123	137	142	144	162	136
Textile	-	38	35	28	23	21
Mining	1,269	1,305	1,539	1,611	1,707	1,605
Others Industries	604	762	845	920	1,090	1,045
Transport	64,458	69,112	71,027	69,926	60,554	64,217
Power Sector	396	379	516	576	472	519
Reseller	8,756	9,398	9,651	9,518	8,544	8,962
Miscellaneous	2,465	2,167	2073	2,201	2,444	2,835
Total	**79,067**	**84,360**	**86,980**	**86,027**	**76,054**	**80,348**

Table 28 presents Naphtha consumption in various sectors. It can be seen from the table that Industry is the main consumer of Naphtha. Petrochemical industry consumed 77% of total Naphtha consumption in 2016-17. This share increased to 83% in 2021-22. There is an overall 2% CAGR growth in Naphtha consumption from 2016-17 to 2021-22.

Table 28: Naphtha Consumption by Various Sectors in India from 2016-17 to 2021-22, in ktoe

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Industry	12,156	12,185	12,899	13,451	13,888	14,355
PetroChemicals	11,537	11,312	11,979	12,288	12,813	13,451
Fertilizer	394	415	397	169	74	-
Others Industries	225	458	523	994	1,001	904
Power Sector	68	75	6	0.5	79	6.7
Imports	2,737	2,303	3,063	2,670	1,966	1,771
Total	**14,961**	**14,563**	**15,968**	**16,122**	**15,933**	**16,133**

Table 29 presents kerosene consumption in various sectors in India. Household consumed more than 90% of India's total kerosene consumption in 2016-17, which decreased to 86% in 2021-22.

Kerosene consumption has decreased in all sectors. Overall there is 23% CAGR decrease from 2016-17 to 2021-22.

Table 29: Kerosene Consumption by Various Sectors in India from 2016-17 to 2021-22, in ktoe

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Industry	88	101	102	90	72	67
Household	5,431	3,797	3,376	2,272	1,658	1,350
Miscellaneous	121	119	136	142	149	144
Total	5,640	4,018	3,614	2,505	1,879	1,561

Table 30 presents petcoke consumption in various sectors in India. There is an overall fall of 8% in petcoke in India from 2016-17 to 2021-22.

Table 30: Petcoke Consumption by Various Sectors in India from 2016-17 to 2021-22, in ktoe

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Miscellaneous	17,733	18,986	15,796	16,064	11,548	11,671
Total	17,733	18,986	15,796	16,064	11,548	11,671

Table 31 presents petroleum lubricant consumption in various sectors in India. There is an overall 6% growth in consumption of petroleum lubricants in India from 2016-17 to 2021-22.

Table 31: Petroleum Lubricant Consumption by Various Sectors in India from 2016-17 to 2021-22, in ktoe

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Miscellaneous	3,331	3,729	3,521	3,680	3,933	4,387
Total	3,331	3,728	3,521	3,680	3,933	4,387

Table 32 presents bitumen consumption in various sectors in India. There is an overall 6% growth in consumption of bitumen in India from 2016-17 to 2021-22.

Table 32: Bitumen Consumption by Various Sectors in India from 2016-17 to 2021-22, in ktoe

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Miscellaneous	5,698	5,842	6,439	6,452	7,223	7,559
Total	5,698	5,842	6,439	6,452	7,223	7,559

Table 33 presents petrol consumption in India. Overall there is 5% CAGR growth in petrol consumption. It must be noted that a large part of petrol consumption goes to reseller category, therefore there is a high share of petrol in miscellaneous category.

Table 33: Petrol Consumption by Various Sectors in India from 2016-17 to 2021-22, in ktoe

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Transport	24,777	27,300	29,507	31,282	29,184	32,204
Total	24,777	27,300	29,507	31,282	29,184	32,204

Table 34 presents natural gas consumption in various sectors. Power sector is the largest consumer of natural gas for energy use. However it must be noted that natural gas finds its utility in the non-energy use in industries as well.

Overall there is a 3% CAGR increase in the energy derived from natural gas in Indian from 2016-17 to 2021-22.

Table 34: Natural Gas Consumption by Various Sectors in India from 2016-17 to 2021-22, in ktoe

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Energy Use	25,297	27,269	28,505	30,080	28,732	32,714
Agriculture	152	157	159	166	147	129
Industry	659	829	901	582	461	688
Others (City Network)[13]	11,582	13,622	14,664	16,643	15,338	15,806
Power Sector	9,641.28	9,983.24	9,964.15	9,196.40	8,993.88	8,430.31
Miscellaneous	3,261.07	2,678	2,816	3,493	3,792	7,660
Industry Non Energy Use	17,001.72	16,582	16,183	16,808	17,845	18,324
Imports	3,931	5,261	5,773	6,351	3,899	2,005
Total	**46,229**	**49,111**	**50,461**	**53,240**	**50,476**	**53,043**

Table 35 presents LPG consumption in various sectors in India. Household is the major consumer of LPG in India. Almost 90% of total LPG consumption is attributed to household sector.

There is 39% CAGR increase in LPG consumption in agriculture sector from 2016-17 to 2021-22. However in the household sector, there is a 8% growth. Overall LPG consumption has shown a 7% CAGR growth from 2016-17 to 2021-22.

Table 35: LPG Consumption by Various Sectors in India from 2016-17 to 2021-22, in ktoe

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Agriculture	9	8	25	29	32	34
Industry	246.3	231.7	231.7	172.9	245.2	205.7
PetroChemicals	13	6	27	23	40	47
Textile	2	2	2	3	2	2
Others Industries	230	222	202	145	200	152
Household	21,324	22,997	24,552	26,075	28,394	28,817
Transport	189	209	204	195	134	139
Power Sector	2	1	2	1	-	-
Miscellaneous*	636	570	457	323	203	284
Commercial	2,006	2,357	2,671	2,953	2,131	2,530
Imports	485	411	357	231	72	86
Total	**24,417**	**26,377**	**28,144**	**29,752**	**31,140**	**32,012**

Table 36 presents furnace oil consumption in various sectors in India. Share of furnace oil consumption in industry has increased from 36% to 43% in 2016-17 to 2021-22.

Overall there has been a 4% CAGR decline in total furnace oil consumption. Furnace oil consumption of cement has witnessed a 14% CAGR growth from 2016-17 to 2021-22. While in the transport sector, there is a 21% CAGR growth in the same years.

Table 36: Furnace Oil Consumption by Various Sectors in India from 2016-17 to 2021-22, in ktoe

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Agriculture	54	52	82	74	84	68
Industry	2,686	2,530	2,758	2,333	2,060	2,326
PetroChemicals	250	254	309	252	237	244
Cement	13	14	21	27	23	24
Textile	78	48	51	43	37	28
Fertilizer	511	543	482	405	309	358
Aluminum	271	250	405	355	366	409
Mining	75	71	57	88	96	134
Others Industries	1,489	1,349	1,432	1,164	992	1,129
Transport	465	630	824	890	1,071	1,214
Power Sector	378	329	355	317	237	326
Miscellaneous	2,604	2,340	1,519	1,465	1,393	1,455
Reseller	374	337	313	304	281	221
Imports	822	704	641	812	331	477
Total	**7,384**	**6,921**	**6,493**	**6,196**	**5,458**	**6,087**

Table 37 presents electricity consumption in various sectors in India. Industry is the largest electricity consumer in India with a share of 41%, followed by household consuming 26% of total electricity consumption.

There has been an overall growth of 4% CAGR of electricity consumption which is spread across all sectors uniformly.

Table 37: Electricity Consumption by Various Sectors in India from 2016-17 to 2021-22, in ktoe

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Agriculture	16,420	17,115	18,332	18,150	19,010	19,671
Industry	37,814	40,254	44,599	45,769	43,704	45,828
Household	21,975	23,498	24,760	26,521	28,416	28,691
Transport	1,347	1,497	1,618	1,645	1,260	1,701
Miscellaneous	5,884	6,085	6,190	6,016	5,816	6,228
Commercial	7,716	8,054	8,438	9,109	7,469	9,234
Total	91,156	96,502	103,937	107,211	105,675	111,352

Table 38 presents energy supply and consumption of various energy products from 2016-17 to 2021-22. It can be seen from table 38 that more than 90% of the coal supplied in India is consumed. There can be seen a complete match between supply and consumption of energy products like ATF, Diesel, Lubes, Bitumen, Petrol, LPG and Electricity.

However there are some energy products which show a difference in energy supply and demand. The difference in supply and consumption of coal can be accounted to losses during transportation from the mine site to the intended destination. It can occur due to various factors such as improper handling, spillage, theft, or other logistical challenges, leading to economic losses and mismatching between coal supply and consumption.

Natural gas is used as feedstock in petrochemical, fertilizer and sponge iron industry. Almost 36% of total consumed natural gas is used for non- energy purpose and are therefore not taken into account for preparation of energy balance, hence the difference between natural gas supply and consumption.

Kerosene is consumed in many unregulated sectors due to its low cost and high availability. It is used for cooking, heating and lighting in household which do not have access to electricity or clean energy, especially in developing countries. Therefore underestimating kerosene consumption in India.

The difference in other petroleum products is due to their use for non-energy purposes.

Table 38: Fuelwise Consumption of energy products in India from 2016-17 to 2021-22, in ktoe

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Coal	153,837	159,462	162,683	152,312	165,974	170897
Naphtha	14,961	14,563	15,968	16,122	15,933	16,133
ATF	7,489	8,168	8,883	8,558	3,956	5,359
Diesel	78,756	84,074	86,554	85,567	75,670	79,907
Lubes	3,331	3,729	3,521	3,680	3,933	4,387
Bitumen	5,698	5,842	6,439	6,452	7,223	7,559
Petcoke	17,733	18,986	15,796	16,064	11,548	11,671
kerosene	5,639	4,018	3,615	2,504	1,878	1,561
Petrol	24,777	27,300	29,507	31,282	29,184	32,204
Other Petroleum Products	28,688	31,578	36,941	39,797	37,678	41,135
Natural gas	15,656	17,286	18,541	20,884	19,738	24,284
LPG	24,897	26,785	28,500	29,980	31,211	32,062
Electricity consumption	91,156	96,502	103,937	107,211	105,675	111,352
Total	**472,618**	**498,293**	**520,885**	**520,413**	**509,601**	**538,510**

Table 39: Balancing Energy Supply and Demand from 2016-17 to 2021-22, in ktoe

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Total Energy Supply	669,193	695,902	748,764	764,739	709,570	754,981
Total Energy Consumption	472,618	498,293	520,885	520,413	509,601	538,510

The above tables can help in understanding the energy consumption and supply from different energy products from 2016-17 to 2021-22. However it must be noted that there is scope of improvements in India's energy data reporting methodologies in context of adopting the same units, and level of granularity for sector/ industries. Reporting of granulated sector wise consumption and production data can add as a knowledge base for better understanding of India's energy sector. Standardization of energy data reporting can enable better comparison of India's energy landscape with other countries. Therefore, the next chapter presents the scope of improvement in India's energy data reporting.

Conclusion

Using Indian coal conversion factors has enabled to produce a much more realistic picture of the energy supply and consumption in India.

Use of Indian coal conversion factors has also brought down the energy supply by almost 18%. The following table compares India's total primary energy supply using IEA and Indian coal conversion factors.

Table 40: Energy Supply in India from 2016-17 to 2021-22 using IEA and Indian coal conversion factors, in ktoe

Year	Final Energy Supply (Using IEA Conversion Factors)	Final Energy Supply (Using Indian CF (GCV))
2016-17	822,689	669,193
2017-18	839,059	695,902
2018-19	906,273	748,764
2019-20	944,363	764,739
2020-21	883,152	709,570
2021-22	897,446	754,981

The following table presents the final energy consumption in India from 2016-17 to 2021-22 using IEA and Indian conversion factors. It can be seen that there has been almost 8% reduction in the energy consumption of India using Indian conversion factors for coal.

Table 41: Energy Consumption in India from 2016-17 to 2021-22 using IEA and Indian coal conversion factors, in ktoe

Year	Final consumption (Using IEA Conversion Factors)	Final consumption (Using Indian CF(GCV))
2016-17	519,341	476,368
2017-18	545,314	500,781
2018-19	584,252	521,017
2019-20	578,527	516,167
2020-21	554,349	507,160
2021-22	570,534	533,487

It can be seen from the table below that the share of electricity in total energy consumption has reached a high of 21%.

Table 42: Energy Consumption and Electricity Consumption in India from 2016-17 to 2021-22, in ktoe

Year	Final consumption (Using Indian Conversion Factors)	Electricity Consumption	% share
2016-17	476,368	91,156	19.1 %
2017-18	500,781	96,502	19.3 %
2018-19	521,017	103,937	19.9%
2019-20	516,167	107,211	20.7 %
2020-21	507,160	105,675	20.8 %
2021-22	533,487	111,352	20.9 %

Chapter 6: Scope of Improvements in India's Energy Data Reporting

Collection and dissemination of energy data is an exercise that needs continuous improvement. It involves adopting best practices in energy data reporting, standardizing definitions and of all key concepts of energy sectors, mobilization of ministries and data collection agencies for collecting energy supply and demand data and harmonizing methodologies and format for data collection and reporting. Therefore, a vision for improvement in energy data reporting has already been developed and is being worked upon. This chapter discusses scope of improvement in India's energy data reporting. This chapter also discusses the vision document of energy data reporting in India.

6.1 Scope of Improvement in Energy Supply Data

There exists limited data on non-commercial energy sources such as biomass although these modes fulfill significant energy needs. There appeared a need to bridge the existing gap in the exploration side of data (i.e., 2D, and 3D surveys). At the same time information currently available but difficult to access could be made available with some extra effort. There is also a possibility that a bigger chunk of data could be collected from government-subsidized projects and disseminated. Available data can be disseminated in open formats that are machine readable as recommended for National Data Sharing and Accessibility Policy (NDSAP) implementation.

Following are the identified data gaps from Coal, Petroleum & Natural Gas, Electricity and Renewables. Considering the Terms of References, they have been reflected in three aspects of Data Collection, Dissemination and Standardization.

6.1.1 Coal

Data Collection

» Data on Initial in place reserves (MTOE/MTCE)

» Balance recoverable reserves (MTOE/MTCE)

» Data on 'Grade slippage' (GCVs-Kcal/kg)

Data Dissemination

» Calorific value of Coking coal (MTOE-Kcal/kg))

» Grade-wise monthly production of coal (MTOE)

» Monthly washery-wise dispatch data (MTOE)

Data Standardization

» Use of NCV for energy balance instead of GCV (yearly basis kJ/kg)

» Reporting of both GCV/NCV of different grades of coal

» Weighted Average GCV for Indian coal (yearly basis kJ/Kg)

» Mismatch of avg. GCV consideration by CCO and MoSPI

Some of the data listed above may be scattered across various entities (such as CMPDI), coal companies and industry associations. The responsible entity should collect and publish this data in one place, while it should make efforts to collect data that do not exist.

There are issues related to coal sizing; it is not possible to claim compensation even after the detection of variations in the size of coal.

6.1.2 Petroleum & Natural Gas

Data Collection

» Data related to biogas (Volume (MCM))

» Data related to bio-ethanol distilleries capacity (MMT or Crore Litre)

Dissemination

» Basin-wise monthly production data (there are 26 sedimentary basins)

» Exploration activity-related data (2D/3D surveys (LKM/SQKm)- yearly basis

» No. of wells drilled per year for both exploratory and development drilling

» State-wise data on biofuel blending (%) percentage- Monthly

» Pricing of domestic crude oil (USD/BBL)- daily, weekly, monthly and yearly

» Petroleum products prices (current and short-term projection)

» The data related to Biofuel blend percentage is available but not published.

6.1.3 Electricity

Data Collection

» Captive plant capacity

» Decentralized: Micro Grids/Mini Grids capacity

» Installation of smart meters - state wise

Dissemination

» State-wise RPO achievement

» RE-curtailments (MW)

Since electricity comes from Coal, Petroleum & Natural Gas and Renewables there should be consistency between the data reported.

6.1.4 Renewables

Data Collection

» Estimation of biomass potential (state-wise types of biomass and aggregate at national level)

» Current use of bioenergy (CBG, ethanol and biomass power) in the primary energy mix

» Data on solar collectors (such as water heaters) installed and operational status.

» Land use data for ground-mounted solar and wind energy

» Geothermal energy-potential and tidal energy potential (estimates)

Data Dissemination

» Grid interactive RE disaggregation: Solar PV, Floating Solar, Solar CSP, Rooftop, Solar Pump, Hybrid

» Discovered tariff chart (historical)

» With respect to primary energy balance, the utilization of biomass is required to work out its percentage share in India's energy mix. It is also suggested that Both MW and MU data in a desegregated manner for RE would be useful.

6.2 Scope of Improvement in Energy ConsumptionData Reporting

6.2.1 Residential Energy Demand Data

Energy consumption in the residential sector accounted for 10% of the total energy consumption in the year 2020-21, while for the preceding years, 8-10% of India's total energy consumed was used by the residential sector. To improvise energy data reporting in the residential sector it is proposed that the ambit of National Sample Survey14 (which conducts household level survey) to collect household socio- economic data in India be widened and made more frequent to include questions on energy consumption.

It is proposed that the NSSO questionnaire on assessing household expenditure data be modified to include questions on energy consumption to rightly assess residential energy consumption by fuels. Table 43 presents the template of NSSO questionnaire and Table 44 and Table 45 show the proposed changes in the NSSO questionnaire.

Table 43: The template of NSSO questionnaire

[3] household Characteristics				
household size			during July 2010 to June 2011	14. land cultivated (0.000ha)
2. principal Industry (NIC-2008)	Description			
	Code(5-digit)			15. land irrigated (0.000ha)
3. principal occupation (NCO-2004)	Description		primary source of energy for	16. cooking (code)
	Code(3-digit)			17. lighting (code)
4. household type (code)			18. dwelling unit code (owned-1, hired-2, no dwelling unit-3, others-9)	
5. religion (Code)				
6. social group (code)			19. is any member of the household is regular salary earner?(Yes-1, No-2)	
7. whether owns any land(yes-1, no-2)				
8. If yes in item 7, type of land owned (homestead only-1, homestead and other land -2, other land only-3)			20. did the household perform any ceremony during the last 30 days?(yes-1, no-2)	
land as on the date of survey(in 0.000 hectares)			21. no. of meals served to non-household members during the last 30 days	
9. owned				
10. leased-in			22. does the household possess ration card? (yes-1, no-2)	
11. otherwise possessed (neither owned nor leased-in)				
		23. if yes in item 22, type of ration card(code)		
12. leased-out			monthly per capita expenditure (Rs. 0.00)	24.URP (Item 48, bl.12)
Total possessed [items (9+10+11-12)]				25. MRP (Item 49,bl.12)

Item 16: primary source of energy for cooking: coke, coal-01, firewood and chips-02, LPG-03, gobar gas-04, dung cake-05, charcoal-06, kerosene-07, electricity-08, others-09, no coking arrangement-10

Item 17: primary source of energy for lighting: kerosene-01, other oil-2, gas-03, candle-04, electricity-05, others-09, no lighting arrangement-6

Table 43: The template of NSSO questionnaire

[6] consumption of energy (fuel, light& household appliances) during the last 30days ended on.....							
item	code	Consumption out of home produce		Total consumption			Sources
		quantity@ (0.000)	Value (Rs.)	quantity@ (0.000)		Value (Rs.)	
(2)	(1)	(3)	(4)	(5)		(6)	(7)
coke	330						
firewood and chips	331						*
electricity(std.unit)	332						
dung cake	333						1
kerosene-PDS (litre)	334						*
kerosene-other source (litre)	335						
matches (box)	336						*
coal	337						
LPG [excel. Conveyance]	338						*
charcoal	340						
candle(no.)	341						
gobar gas	342						
petrol(litre) [excel. Conveyance]	343						*
diesel (litre) [excel. conveyance]	344						*
other fuel	345						
fuel and light: s.t. (330-345)	349						

@unit is kg unless otherwise specified in col (1).

sSource code: *only purchase-1, only home grown stock-2. Both purchase and home grown stock-3, only free collection-4, only exchange of goods services-5, only gifts/charities-6, others-9.*

**Source code cannot be 2,3 or 4 for these items.*

Table 44: Proposed Changes in NSSO Questionnaire as per Demand Side Energy template.

Primary Source of Energy for Cooking					Primary Source of Energy for Lighting and Heating		Primary Source of Energy for Cooling
Items	Consumption out of home produce		Total Consumption		Consumption out of home produce	Total Consumption	Total Consumption
	Quantity	Value in Rs	Quantity	Value in Rs	Quantity	Value in Rs	
Coal							
Charcoal							
Electricity							
LPG							
PNG							
Firewood and Chips							
Cowdung Gas							
Dung Cakes							
Kerosene							
Diesel							
LPG							
PNG							
Candle							

Table 45: Ownership of Star Rated Electrical Appliances

Appliance	No of items	Watts	Hours of Usage	Value (in Rs)
Room Air Conditioner				
Refrigerator				
Tubular Florescent Lamp				
LED Lamps				
Color TV				
Electric Geyser				
Ceiling Fans				

6.2.2 Reporting Industry Energy Demand Data

Annual Survey of Industries is the principal source of industrial statistics in India. It is used to provide information to assess the changes in growth and structure of registered units in the manufacturing sector. To improve energy reporting in the industrial sector, it is proposed that Block H (Table 46) of the Annual Survey of Industries be modified to include more fuel types in energy consumption, represented in Table 47.

Table 46: Block H of the Annual Survey of Industries

ASI Schedule 2020-21 | **DSL No** | | | | | | | | **PSL No** | | | | |

Block H: Indigenous input items consumed (if needed, additional sheets may be used for recording input items with serial nos. starting from 25)						
Sl. No.	**Item description**	**Item code (NPC-MS)**	**Unit of quantity**	**Quantity consumed**	**Purchase value (in Rs.)**	**Rate per unit (in Rs.)**
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Major ten basic items (indigenous)					
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.	Other basic items (indigenous)*	9920100				
12.	Total basic items (items 1 to 11)	9990100				
13.	Non-basic chemicals – all kinds	9920300				
14.	Packing items	9990800				
15.	Electricity own generated	9990400	KWH			
16.	Electricity purchased & consumed	9990500	KWH			
17.	Petrol, diesel, oil, lubricants consumed	9990600				
18.	Coal consumed	9990700	Tonne			
19	Gas consumed	9990900	KG			
20.	Other fuel consumed	9920400				
21.	Consumable store	9922000				
22.	Total non-basic items (items 13 to 21)	9992000				
23.	Total inputs (items 12+ 22)	9993000				
24.	Any additional requirement of electricity (unmet demand)	9999999	KWH			

** Full description of items not in NPC-MS 2011 (Revised):*

Table 47: Proposed Changes in Block H of ASI

DSL No		PSL No	

Block H: Indigenous input items consumed (if needed, additional sheets may be used for recording input items with serial nos. starting from 25)

Sl. No.	Item description	Item code (NPC-MS)	Unit of quantity	Quantity consumed	Purchase value (in Rs.)	Rate per unit (in Rs.)
1	2	3	4	5	6	7
	Major ten basic items (indigenous)					
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.	Other basic items (indigenous)*	9920100				
12.	Total basic items (items 1 to 11)	9990100				
13.	Non-basic chemicals – all kinds	9920300				
14.	Packing items	9990800				
15.	Electricity self-generated	9990400	kWh			
16.	Electricity purchased & consumed	9990500	kWh			
	Solar					
	Wind					
	Hydro					
	Others					

* These changes are only indicative and are under improvement

TABLE 47: Proposed Changes in Block H of ASI.

17.	Petroleum Products consumed				
	LPG				
	Petrol				
	Naphtha				
	Kerosene				
	Aviation Turbine Fuel				
	High Speed Diesel Oil				
	Light Diesel Oil				
	Fuel Oil				
	Lubricants				
	Bitumen				
	Petroleum coke				
	Other Fuels				
	Coal Consumed				
	Lignite Consumed				
18.	Gas consumed	9990900	KG		
19.	Consumable store	9922000			
20.	Total non-basic items (items 13 to 21)	9992000			
21.	**Total inputs (items 12+ 22)**	**9993000**			
22.	Any additional requirement of electricity (unmet demand)	**9999999**	KWH		

`* Full description of items not in NPC-MS 2011 (Revised):

6.2.3 Calorific Value of Coal

Calorific Value of a fuel is defined as the amount of heat obtained from one unit of fuel. It is important for an energy balance as original units in which energy products are measured need to be converted into common measurable units of energy.

The Gross Calorific Value (GCV) is a measure of the total amount of heat that is produced by combustion, including latent heat. Net Calorific Value (NCV) excludes latent heat. Hence, NCV is the actual amount of heat available for practical use. The IRES recommends using NCV rather than GCV for preparing energy balance of a country.

Same energy products carry same energy content in them, but in practice this does not happen. This is largely due to difference in chemical composition of same energy products. Therefore arises the need of having different calorific values for similar energy products.

There are different types of coal variety available with different calorific values. Tables 48 and 49 give different Gross and Net calorific values of coking and non-coking coal. Table 50 compiles GCV used by different agencies. However, given that different varieties of coal produce different amounts of energy, using a single GCV for all types of coal can lead to misleading data on energy production. Therefore, there is a need to harmonize the system and use Grade-wise specific calorific values to improve energy reporting.

Table 48: Grading of Coking Coal- based on ash Content, and their GCV and NCV

Grade	Ash Content	GCV (kcal/kg)	NCV (kcal/kg)
Steel Grade - I	Not exceeding 15%	7094	6955
Steel Grade - II	Exceeding 15% but not exceeding 18%	6945	6806
Washery Grade - I	Exceeding 18% but not exceeding 21%	6647	5863
Washery Grade – II	Exceeding 21% but not exceeding 24%	6349	5317
Washery Grade – III	Exceeding 24% but not exceeding 28%	6002	4623
Washery Grade – IV	Exceeding 28% but not exceeding 35%	5456	3928
Washery Grade - V	Exceeding 35% but not exceeding 42%	4762	4630
Washery Grade - VI	Exceeding 42% but not exceeding 49%	4067	3935
Semi Coking- I	Less than 19% (Ash+ Moisture)	6915	6508
Semi Coking- II	19 to 24% (Ash+ Moisture)	6468	6210

Table 49: Non-coking Coal- gradation based on GCV and their NCV

Coal Grade	GCV Band (kcal/kg)	NCV kcal/kg
G 1	Exceeding 7000	6833
G 2	Exceeding 6700 and not exceeding 7000	6683
G 3	Exceeding 6400 and not exceeding 6700	6383
G 4	Exceeding 6100 and not exceeding 6400	6083
G 5	Exceeding 5800 and not exceeding 6100	5783
G 6	Exceeding 5500 and not exceeding 5800	5483
G 7	Exceeding 5200 and not exceeding 5500	5183
G 8	Exceeding 4900 and not exceeding 5200	4883
G 9	Exceeding 4600 and not exceeding 4900	4583
G 10	Exceeding 4300 and not exceeding 4600	4283
G 11	Exceeding 4000 and not exceeding 4300	3983
G 12	Exceeding 3700 and not exceeding 4000	3683
G 13	Exceeding 3400 and not exceeding 3700	3383
G 14	Exceeding 3100 and not exceeding 3400	3083
G 15	Exceeding 2800 and not exceeding 3100	2783
G 16	Exceeding 2500 and not exceeding 2800	2483
G 17	Exceeding 2200 and not exceeding 2500	2183

Table 50: Representative GCV used by different Data Reporting Agencies

Coal Grade	GCV Band (kcal/kg)	Representative GCF (kcal/kg.) Used by				
		MOSPI	BP Statistics	IESS 2047	BEE	IEA
G 1	Exceeding 7000					
G 2	Exceeding 6700 and not exceeding 7000					
G 3	Exceeding 6400 and not exceeding 6700					
G 4	Exceeding 6100 and not exceeding 6400					
G 5	Exceeding 5800 and not exceeding 6100					
G 6	Exceeding 5500 and not exceeding 5800					
G 7	Exceeding 5200 and not exceeding 5500					
G 8	Exceeding 4900 and not exceeding 5200					
G 9	Exceeding 4600 and not exceeding 4900	3614	4009	3998	4000	3400-4600
G 10	Exceeding 4300 and not exceeding 4600					
G 11	Exceeding 4000 and not exceeding 4300					
G 12	Exceeding 3700 and not exceeding 4000					
G 13	Exceeding 3400 and not exceeding 3700					
G 14	Exceeding 3100 and not exceeding 3400					
G 15	Exceeding 2800 and not exceeding 3100					
G 16	Exceeding 2500 and not exceeding 2800					
G 17	Exceeding 2200 and not exceeding 2500					

Source: Report of the Inter-Ministerial Committee on Energy Data Management

6.2.4 Conversion Factors of Petroleum Products

Various energy products are measured in different values depending on their state. In an energy statistic, all the entries should be expressed in same unit. The conversion of these units to one standard unit of energy should be through application of appropriate conversion factors.

Different agencies collect and report data for different energy resources which is compiled by MOSPI in the form of energy balance of the country. While MOSPI uses conversion factors used by IEA, MOPNG has its factors, as shown in Table 51. There is a need to harmonize conversion factors of various petroleum products to make energy data reporting robust. You may note that for the most commonly used products, the convergence is good.

TABLE 51: Multiplier for Conversion of one Metric Tonne of Petroleum Products to one Tonne of Oil Equivalent

Product	IEA/ MOSPI	PPAC/MOPNG
HSD	1.03	1.03
Petrol	1.07	1.07
Heavy fuel oil	0.98	0.98
Jet fuel	1.06	1.06
LPG	1.13	1.13
Naphtha	1.07	1.13
Aviation Gasoline	1.07	1.07
Kerosene	1.04	1.04
Gas/ Diesel	1.03	1.03
Residual Fuel Oil	0.96	0.98
Others	0.95	0.96
White Spirit	0.95	1.02
Lubricants	0.96	1.00
Bitumen	0.96	0.93
Paraffin Waxes	0.96	0.96
Petroleum Coke	0.74	0.74

Source; IPNG Statistics, 2022 and Key World Energy Statistics, Conversion Factors

6.3 Vision Document of Energy Data Reporting

Energy Data Management Unit is given the responsibility of ensuring a robust energy data reporting mechanism in India. Therefore, in order to make this reporting more exhaustive a vision data template has been prepared. It is visioned that energy data must be reported for all energy resources their end-use consumption. Figure 23 represents EDMU's vision template.

	Coal			Petroleum											Natural Gas	Renewable Energy					Electricity
	Coal	Lignite	TOTAL	High Speed Diesel	Light Diesel Oil	Motor Gasoline	Motor Spirit	Furnace Oil	Aviation Turbine Fuel	Fuel Oil	Low Sulphur Heavy	LPG	Naptha	TOTAL		Solar	Wind	Hydro	Nuclear & Hydroge	BioMass and Others	
Industries																					
Mining	ASI schedule can be modified to incorporate the required changes																				
Manufacture of textiles																					
Manufacture of chemicals and chemical products																					
Manufacture of other non-metallic mineral products																					
Glass																					
Cement																					
Manufacture of Basic Iron and Steel																					
Non ferrour Metals																					
Manufacture of fabricated metal products, except machinery and equipment																					
Machinery																					
Construction of buildings																					
Services																					
Residential	Line minstries/departments reporting data on energy consumption (including NSSO) will be approached for discussion and data collection																				
Cooking																					
Lighting																					
Cooling																					
Transport																					
Road	Line minstries/departments reporting data on energy consumption (including NSSO) will be approached for discussion and data collection																				
Domestic aviation																					
Rail																					
Domestic Water Transport																					
Non-specified (transport)																					
Agriculture																					
Services																					
Non-Energy Uses																					
Electricity/ Power																					
Thermal																					

Figure 24: Vision Template of EDMU

Chapter 7: Energy Conservation Measures in India

7.1 Impact Assessment of Energy Efficiency Measures in India

India has been experiencing the rapid urbanization that has made significant structural changes across all the sectors. These developments have a positive impact on the economic situation of the country that led to increased energy consumption across all the sectors (BEE, Impact Assessment, 2021-22). India also ranked highest in terms of growth rate of energy consumption in the world. India's energy consumption is projected to grow fastest among global economies and account for 11% of global energy demand by 2040 (BEE, Impact Assessment, 2021-22).

As the country updated its national determined contributions (NDC) targets which intends to reduce emission intensity of its GDP, the energy efficient measures will play an important role in achieving these targets set by the government.

Energy efficiency measure is the concept of reducing the energy consumption by using less energy or energy efficient appliances to lower costs and reduce environmental impact which brings down the power demand and provide considerable potential to promote low carbon transformation and energy saving. It is one of the most promising way to achieve net zero target set by the Indian government. There are several schemes launched by the government to conserve energy. These schemes are spanning across major energy consuming sectors in India such as Industry, Commercial, Residential, Transport, Agriculture, Municipal etc., along with cross cutting mechanisms for realization of energy savings.

There are multiple energy conservation programmes initiated by Bureau of Energy Efficiency as well as complimenting programs by other agencies and institutions in response towards NDC targets where energy efficiency plays a vital role in complying with these targets.

There are several schemes that have been launched at the national, state and sectoral levels which are in operation, to achieve the goal of energy efficiency in India. Major energy consuming sectors and prominent schemes in these sectors are presented in the table provided below:

Table 52: Energy Efficiency Schemes of Bureau of Energy Efficiency

Sector	Sub-Sector	Scheme
Industry	Large Industry	PAT
	MSME (Micro Small and Medium Enterprises)	BEE-SME
		BEE-UNIDO-GEF (The Global Environment Facility)
		BEE-WBSIDBI-GEF
Agriculture	AgDSM (Agriculture Demand Side Management)	Star Rated Pumps
Transport	Road Transport	CAFE (Corporate Average Fuel Economy)
		FAME (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles.)
	Railways	Traction & Non-Traction
Building	Residential appliances	Standard & Labelling
		UJALA (Unnat Jyoti by Affordable LEDs for All)
	Residential building	Residential Labeling
		EcoNiwas Samhita
	Commercial building	ECBC (Energy Conservation Building Code)
		Star Rated Building
		BEEP (Building Energy Efficiency Programme)
Municipality	MuDSM (Municipality Demand Side Management)	SLNP (Street Lighting National Program)
		MEEP (Municipality Energy Efficient Program)

Source: BEE, Impact Assessment, 2021-22

The adoption of energy efficiency schemes/programmes has led to the overall energy savings of 44.43 Mtoe, i.e., 6.0% of the total primary energy supply of the country for the year 2021-22. Energy savings from several schemes and are presented in the below table:

Table 53: Energy Savings from Various Schemes of BEE, 2021-22

Program/Scheme	Sector	Electricity Savings	Thermal Savings	Total Energy Savings	GHG Reduction	Monetary Savings
		(BU)	(MTOE)	(MTOE)	($MtCO_2$)	(INR Crore)
PAT- III	Large Industry	0.62	1.59	1.59	1.59	3205.30
PAT- II		36.47	10.95	14.08	68.43	42020.59
PAT- I		3.01	9.25	8.67	31.00	9500.00
PCRA EE Programs		0.01	0.00027	0.0009	0.0044	5.98
PRSF	MSME	0.05	-	0.0041	0.04	28.74
4E		0.03	0.00010	0.0026	0.02	151.87
GFS		0.01	-	0.0009	0.01	128.36
BEE-GEF-EESL		0.0015	0.0018	0.0019	0.009	4.49
BEE-UNIDO-SME				0.0057	0.038	36.72
BEE-FLCTD		0.0009	0.0000657	0.00007	0.002	1.11
ECBC	Commercial	0.1609	-	0.0121	0.1303	25.46
BEE Star Rating	Buildings	0.2492	-	0.0214	0.2019	39.43
Gree building rating Programme (GRIHA)		0.0882		0.0076	0.0714	13.96
ENS	Residential Buildings	0.0024	-	0.00021	0.0019	0.38
S&L	Multiple (Appliances)	70.43	0.02	6.06	57.05	42258.92
	Others (AgDSM, SEAC, etc.)	0.4693		0.041	0.37	281.57
UJALA	LED Lamps	47.78	-	4.10	38.70	19112.00
	LED (Private Market)	82.00	-	7.05	67.00	32800.00
SLNP	Municipal	8.52	-	0.73	5.87	5109.60
FAME	Transport		0.14	0.14	0.53	1559.88
CAFÉ			1.89	1.89	5.69	4436.35
Total		249.89	23.85	44.43	280.77	160720.8

Source: BEE, Impact Assessment, 2021-22

The above table shows the adoption of all these energy efficiency schemes has led the country an overall thermal energy savings of 23.85 Mtoe, while overall electricity savings are to the tune of 249.88 BU. Total, these energy savings translated into monetary savings of worth INR 160720.8 crores and contributed in reducing 280.77 Million Tonnes of CO_2 emission.

7.2 Share of different schemes in overall Energy saving

Most of these schemes/programmes are essentially cross-sectoral, therefore these schemes successfully managed to save energy across all the demand sectors.

Implementation of energy efficiency interventions has led to the reduction of 33.35 Mtoe in the demand side energy consumption, amounting to 6.34% of the energy demand (525.708 Mtoe) during the year 2021-22. The total energy savings achieved (including both Supply Side and Demand Side sectors of the economy) is of the order of 44.43 Mtoe. These energy savings amount to 6.0% of the total primary energy supply (739.38 Mtoe) during 2021-22.

Table 54: Sector-wise Energy Saving Summary, 2021-22

Sector	Thermal Saving (Mtoe)	Electrical Saving (BU)	Total energy savings (Mtoe)	Emission reduction (Million Tonne of CO_2/year)	Estimated monetary savings (INR crore)
Industry[15]	21.80	40.19	24.36	105.15	55073.72
Domestic[16]	0.019	200.21	17.22	162.75	89129.39
Commercial Buildings[17]	-	0.4980	0.0428	0.4034	78.80
Transport (including Railways)	2.03	-	2.03	6.23	5996.23
Others (including Municipal)	-	8.52	0.73	5.87	5109.60
Agriculture (including Star Rated pumps)	-	0.007	0.006	0.0049	279.98
Total	23.85	249.89	44.43	280.77	160720.8

Source: BEE, Impact Assessment, 2021-22

Note:

1. Industry Sector includes the savings from PAT (Excluding – DISCOM, Buildings, Railways) and MSMEs
2. Domestic Sector includes the savings from S&L (except pump sets and DTs) and savings from UJALA programme

15 Industry Sector includes the savings from PAT (Excluding – DISCOM, Buildings, Railways) and MSMEs

16 Domestic Sector includes the savings from S&L (except pump sets and DTs) and savings from UJALA programme

17 Including saving from DTs

7.3 Impact of Various Energy Efficiency Interventions in India

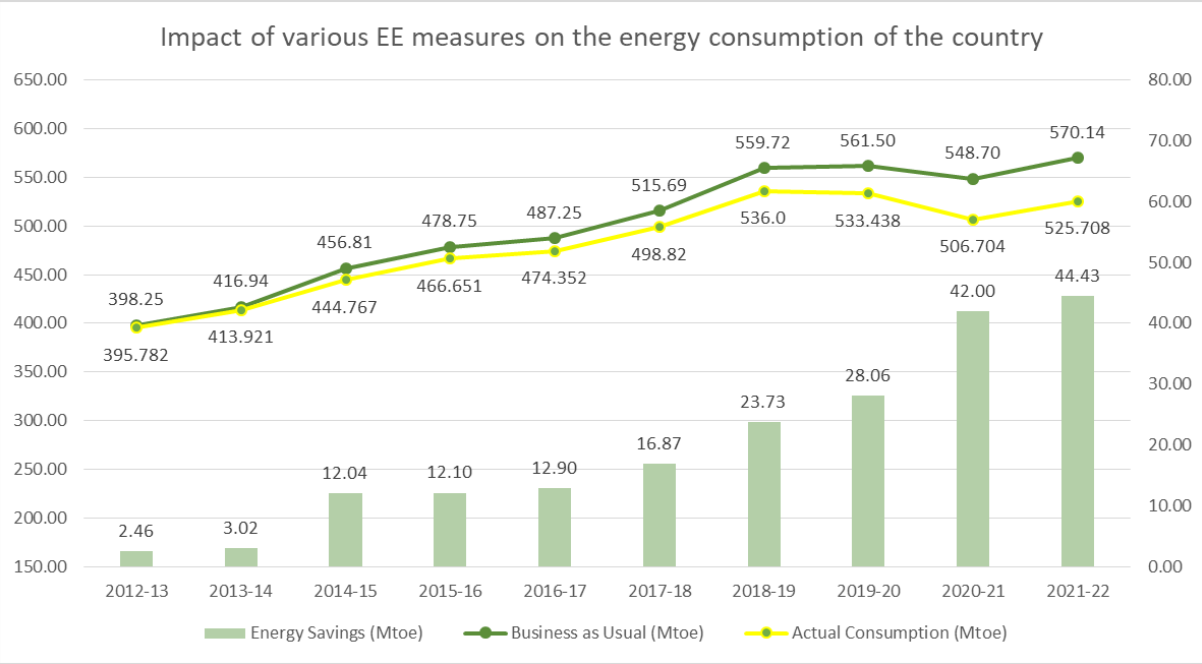


Figure 25: Energy Saving from Various Energy Efficiency Measures in India, in Mtoe, 2021-22

Source: BEE, Impact Assessment, 2021-22

**Impact of various EE interventions has been evaluated using India conversion factors for coal derived from weighted average methodology rather than using a single representative GCV for all grades of coal.*

As per the energy savings data provided by BEE, it is quite obvious that all these schemes/programmes, were mostly successful in generating considerable amount of savings spanning across major energy consuming sectors including Industry, Agriculture, Residential, Commercial, Transport, etc. and creating a culture of energy efficiency in India. The above graph shows the significant increase in the energy saving data during 2012-13 to 2021-22 across all the sectors. These energy efficiency interventions have not only resulted into significant energy savings but have also been successful in building institutional capacity and creating strong awareness for energy efficiency in India.

Chapter 8: Key Findings and Way Forward

The compilation of robust energy data and its outcome can facilitate in achieving the target of energy transition in India along with tracking the results of different policies like renewable energy and energy efficiency etc. Some of the high level outcomes from this report are listed below:

The data provided in this report can help in assessing the status of data availability of various energy products in the country. It can also help in analysing energy related parameters like energy intensity, level of granularity sector-wise, and the conversion factor for energy equivalent factors.

» This report provides detailed data on the production and consumption of various energy products in the country including natural gas, petroleum products, coal, etc. In terms of data availability by fuels, this report provides the detailed data for oil and natural gas whereas the data on coal, electricity, and other renewable fuels like biomass, biofuel, etc. need improvisation which presents the data gaps in India's energy sector. Detailed analysis of energy data in this report provides fuel-wise sectoral energy consumption and supply data. With the help of these data, the trend analysis of energy intensity for each sector can be drawn which can further help in the comparison of energy intensity for each sector.

» This report presents the importance of conversion factors, specific energy consumption and the corresponding energy equivalent in providing realistic data and information. Earlier, MoSPI was using the International Energy Agency (IEA) conversion factors, for reporting India's energy consumption in energy equivalent units. However, IEA conversion factors are not suitable for the Indian scenario. Under EDMU, MoSPI has made a revision in the approach for conversion factors in its latest edition of "Energy Statistics" for the year 2023, wherein it used the conversion factors of coal derived through weighted average methodology rather than using a single representative GCV for all grades of coal. The revision resulted in a decrease in energy supply by 18% from earlier approach in the year 2021-22. Similarly, the energy consumption values are lower by 8% in 2021-22. The share of electrification on consumption side has also increased to 21.2% now. The table given below elaborates the earlier and revised estimates of energy consumption for the last 10 years:

» An in-depth analysis for international data reporting provides the deepened understanding of the global energy data reporting practices and the imperative of standardized and up-to-date data reporting of energy statistics in India.

Based on the analysis done using the energy data collected, few recommendations are suggested:

» ISIC code has been recommended for the classification of industries globally. India adopted ISIC Rev.4 as a basis to classify its industry called National Industrial Classification(NIC). For the industrial classification in India, NIC must be followed by the organisations in order to keep uniformity in the data. Standardization of energy data reporting can enable better comparison of India's energy landscape with other countries.

» A better data availability can help understand the energy profile of the country and the robust energy data can help policy makers in formulating data driven policies. These energy data can also be used in finding the estimation of CO2 emissions.

» Data is the key to track policy progress and to monitor trends over time. The energy data must be linked with the policies and initiatives taken by the government which will help in tracking the progress of the targets set by the government. The detailed data collection will also help in monitoring the policy implementation associated with the energy efficient technologies and the use of green fuels in different energy consuming sectors.

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Annexure I: Key Definitions

TABLE I: Key Definitions of Energy Statistics

Term	Definition
Production	Production is defined as the capture, extraction or manufacture of fuels or energy in forms that are ready for general use.
Exports	All energy products exiting the national territory of a country are called its exports.[18]
Imports	It includes all energy products which are imported into the national territory of a country. [19]
International Marine Bunkers	It refers to the quantities of fuels delivered to merchant ships (including passenger ships) of any nationality for consumption during international voyages transporting goods or passengers. Fuels delivered for consumption by ships during domestic transportation, fishing or military uses are not included here, but are considered part of final consumption of energy. For the purposes of energy statistics, international marine bunkers are not included in exports; they are recorded separately due to their importance.
International Aviation Bunkers	It is defined as quantities of fuels delivered to civil aircraft of any nationality for consumption during international flights transporting goods or passengers. For energy statistics, international aviation bunkers are not included in exports. They are recorded separately due to their importance, e.g. for the estimation of greenhouse gas emissions.
Stock Change	Stock change refers to the quantity of energy products that are preset in national territory and can be used when there are disruptions in the supply of the energy products due to market fluctuations.
Transfer	It is a statistical device used to overcome practical presentation issues which result from changes in use or identity of a product.
Transformation	It refers to the process where a part or all of the energy content of the product is transformed into one or more different products.

TABLE I: Key Definitions of Energy Statistics

Term	Definition
Losses	This refers to the losses during transformation, distribution and transportation of fuels, heat or electricity.
Energy Industry Own Use	It is consumption of fuels or energy for direct use in the production and preparation of fuels and energy.
Non Energy Use	The use of energy products as raw materials for manufacture of products, not for direct use as a source of energy.
Final Consumption	All fuels and energy which is derived to users for both energy and non-energy uses. This does not involve transformation process.
Energy Industries	They are economic units whose principle activity is primary energy production, transformation of energy or distribution of energy.
Other Energy Products	They are economic units (including households) that produce (voluntarily or non-voluntarily) energy for their own consumption and/ or supply energy to other units.

Source: IRES, 2011, United Nations

TABLE II: Definitions of Petroleum Products

Petroleum Products	Petroleum products mainly consist of a mixture of liquid or semi-solid principally hydrocarbons
Crude oil	Crude oil is naturally occurring form of petroleum, mainly in a porous underground formation such as sandstone.
Natural Gas	Natural gas is a gaseous hydrocarbon (mainly consist of methane) from underground deposits, the production of which may be associated with that of crude petroleum. The gas is described as "wet" or "dry" according to the proportion of readily condensable hydrocarbons that it contains.
Liquefied Petroleum Gas	LPG is a mixture of light hydrocarbons, consisting predominately of propane, propene, butanes and butenes, that may be stored and handled in the liquid phase under moderate conditions of pressure and at ambient temperature.
Kerosene	Kerosene is a distillate having a volatility intermediate between that of gasoline and gasoil, with a closed flash point above 38°C. It is majorly designed for the use of domestic & commercial market and for use in aviation gas turbines.
Gas- Oil	Gas-oil is a middle distillate fuel, which may contain some heavy distillate for specified applications. This distillate can be used to formulate automotive gas-oil heating gas-oil and marine distillate fuels.
Automatize gas-oil /diesel fuel	Gas-oil that has been formulated for use in domestic, commercial, and industrial continuous-combustion applications.
Heating gas-oil	Distillate gas-oil that has been formulated for use in distillate (normally vacuum) containing a relatively domestic, commercial and industrial continuous Large amount of paraffin wax combustion applications.
Motor gasoline /petrol GB	Gasoline with or without additives, notably antiknock agents and inhibitors, for use as a fuel in automobile, stationary and other spark-ignition engines, except aircraft engines.
Aviation gasoline	Gasoline for use as a fuel in spark-ignition aviation engines and having a distillation rang usually within the limits of 30 'C and 180 "C.
Naphtha	Light distillate containing no additive, having a distillation range similar to gasoline.

TABLE II: Definitions of Petroleum Products

Bitumen	Bitumen is very viscous or nearly solid, virtually in volatile, adhesive and waterproofing material derived from crude petroleum, or present in natural bitumen, which is completely or nearly completely soluble in toluene and completely soluble in carbon disulphide.
Lubricant	Any substance which, when interposed between that the two surfaces in relative motion, reduces friction or increases wear resistance.
Paraffin wax	Products obtained from distillates, consisting essentially of a mixture of saturated hydrocarbons, solid at ordinary temperatures.
Fuel-oil	Fuel-oil is a heavy distillate, residue or mixture of the two, used as fuel for the production of heat or power.
Petroleum coke	Petroleum coke is a blackish solid product consisting essentially of carbon, usually obtained by severe thermal degradation of petroleum-based feed stocks.

Source: Bureau of Indian Standards

Annexure II: Global Energy Data Reporting Practices

International energy data reporting practices vary across countries and regions, but there are some common standards and guidelines that are followed by many organizations and institutions. Common data reporting standards ensure that energy data is accurate, consistent, and comparable across different countries and regions. Here are some of the key international energy data reporting practices:

1. International Energy Agency (IEA) Reporting Standards: The IEA is an intergovernmental organization that produces a range of energy statistics and their indepth analysis. The IEA has established a set of reporting standards of energy production, consumption and emission that are used by member countries and other organizations to report their energy data. One of the main data reporting standards developed by the IEA is the Energy Statistics Manual.
2. International Organization for Standardization (ISO) Energy Management Standards: The ISO is an international standard-setting organization that has developed a range of standards related to energy management. These standards provide guidance on energy management systems, energy audits, and energy performance indicators.
3. Global Reporting Initiative (GRI) Sustainability Reporting Standards: The GRI is an international organization that has developed a set of sustainability reporting standards. These standards cover a range of topics, including energy management, greenhouse gas emissions, and renewable energy.

Overall, international energy data reporting practices are designed to ensure that energy data is accurate, transparent, and comparable across different countries and regions. By following these standards and guidelines, organizations and countries can improve their energy management practices and contributeto global efforts to address climate change.

United States of America

The United States of America has a well-developed system for energy data reporting. This involves multiple federal agencies responsible for collecting and reporting data on different aspects such as energy production, consumption, and emissions. Following are some of the key organizations and initiatives involved in energy data reporting in the US:

1. Department of Energy (DOE): The DOE is federal's apex agency responsible for promoting energy efficiency and developing new energy technologies. The DOE collects and reports data on a range of energy-related topics, which include energy use in buildings, renewable energy, and energy storage.
2. US Energy Information Administration (EIA): The EIA is an independent agency within the DOE. It is responsible for collecting and reporting data on energy production, consumption, and prices

in the US. The EIA collects data from a variety of sources, including energy companies, state governments, and other federal agencies. The EIA disseminated data through a range of reports and data products, including the Annual Energy Outlook, the Monthly Energy Review, and the State Energy Data System.

3. Environmental Protection Agency (EPA): The EPA is a federal agency responsible for protecting human health and the environment. It collects data on greenhouse gas emissions and other air pollutants.
4. Energy Star: Energy Star is a voluntary program run by the EPA and DOE. It aims to promote energy efficiency in buildings and products. The program provides energy performance ratings and certifications for buildings and products. It collects data on energy savings and emissions reductions achieved through the program.
5. National Renewable Energy Laboratory (NREL): NREL is a federal laboratory that conducts research and development on renewable energy technologies. NREL collects and reports data on renewable energy production, costs, and performance, and produces a range of reports and data products related to renewable energy.

Overall, the US has a robust system for energy data reporting that involves multiple federal agencies and initiatives. The energy data system of US provides policymakers, researchers, and other stakeholders with the data they need to understand energy trends and make informed decisions about energy policy and investment.

European Union

The EU Energy Data Reporting is a framework for collecting, analyzing, and disseminating information on energy consumption, production, and related statistics across the European Union. This framework is governed by the Energy Statistics Regulation (ESR) which provides a legal basis for harmonized EU- wide energy statistics.

Under the ESR, member states are required to collect and report data on energy production, imports, exports, transformation, and consumption on an annual basis. The data covers all forms of energy, including oil, gas, coal, electricity, and renewables.

The collected data is then compiled and disseminated by Eurostat, through various publications and databases, such as the Energy Statistics Yearbook, the Energy Balances and the Electricity and Gas Statistics.

Annexure III: Key Policies on Energy

Table III: Key Policies on Energy in India

Policy/Scheme	Implementation Agency	About Policy/Scheme
National Green Hydrogen Mission	Ministry of New and Renewable Energy	National Green Hydrogen Mission was approved by the Government of India on 4 January 2022.The objective of this mission includes: » Making India a leading producer and supplier of Green Hydrogen in the world » Creation of export opportunities for Green Hydrogen and its derivatives » Reduction in dependence on imported fossil fuels and feedstock » Development of indigenous manufacturing capabilities » Attracting investment and business opportunities for the industry » Creating opportunities for employment and economic development » Supporting R&D projects The mission outcomes projected by 2030 are: » Development of green hydrogen production capacity of at least 5 MMT per annum with an associated renewable energy capacity addition of about 125 GW in the country » Over Rs. 8 lakh crore in total investments » Creation of over six lakh jobs » Cumulative reduction in fossil fuel imports over Rs. 1 lakh crore » Abatement of nearly 50 MMT of annual greenhouse gas emissions

Table III: Key Policies on Energy in India

Policy/Scheme	Implementation Agency	About Policy/Scheme
National Electricity Plan	Central Electricity Authority	National Electricity Plan is a vision document on the development of India's power sector. Central Electricity Authority prepare NEP in accordance with the National Electricity Policy and notify such plan once in 5 years with an aim to: » formulate short term and perspective plan to assess the demand for the planning capacity addition » Coordinate the activities of various planning agencies for the optimal utilization of resources. The first plan was notified in 2007, second plan in 2013, third plan in 2018 and plan for 2022-2027 was notified in 2022. NEP highlights that India is planning to add 333 GW of solar and 134 GW wind capacity by 2031-32. Achievements of the scheme: » The scheduled capacity addition from conventional sources during the period of 2017- 22 was 51,561.1 MW as per National Electricity Plan, 2018. » The capacity addition achieved from conventional sources is 30,668 MW for the year 2021-22. India has achieved a cumulative installed renewable energy capacity (including large hydro) of 156608 MW as on 31.03.2022. » Capacity consisting of Coal (18320 MW), Hydro (4801.5 MW) and Nuclear (3300 MW) envisaged during the period 2017-22 is slipped where COVID-19 being the major reason resulting in delay. » The Installed Capacity of the country as on 31.03.2022 was 398986 MW (excluding 510 MW of Diesel) comprising of 235599 MW thermal, 6,780 MW Nuclear and 156607MW renewables This is considered as a base installed capacity for the study period 2022-32.

Table III: Key Policies on Energy in India

Policy/Scheme	Implementation Agency	About Policy/Scheme
Perform, Achieve and Trade (PAT) 	Bureau of Energy Efficiency, Ministry of Power	PAT scheme has been implemented under the "National Mission on Enhanced Energy Efficiency". It was started in 2012. The objective of this scheme is to increase energy efficiency in Indian industries by reducing specific energy consumption in energy intensive industries with an associated market based mechanism to enhance the cost effectiveness through certification of excess energy saving which can be traded. Achievements of each PAT cycle: » The target for PAT cycle 1 was 6.7 Mtoe. This cycle achieved 8.7 Mtoe energy savings which exceeded the target by 30%. » PAT cycle 2 began on 1st April 2016 resulted in total energy saving of 3.2 Mtoe. » PAT cycle 3 began on 1st April 2017 with an aim to reduce overall energy consumption by 1.0 Mtoe, with targets communicated to 16 designated Consumers for six sectors. This cycle was completed in March 2020 and its implementation resulted in energy savings of 1.7 Mtoe. » PAT cycle 4 started in April 2018. The assessment periods for DCs was from April to July 2021, but was extended to April to July 2022 due to the COVID-19 pandemic. » PAT cycle 5 started in April 2019. The expected energy consumption of 110 DCs is 15.2 Mtoe with an energy savings of 0.5 Mtoe. » PAT cycle 6 started on April, 2020 with an expectation of total energy saving of 1.2 MTOE. » PAT cycle 7 was notified in October 2021 for 2022-23 to 2024-25 with an overall saving target of 6.6 Mtoe.

Table III: Key Policies on Energy in India

Policy/Scheme	Implementation Agency	About Policy/Scheme
Energy Conservation Amendment Act 2022	Ministry of Power	The Energy Conservation (Amendment) Act, 2022 came into force on 1st January 2023. The aim of this amendment is to assist India in achieving its COP-26 commitments. The amendment also aims to promote renewable energy and develop domestic carbon market. The bill has introduced the concept of carbon trading and mandated the use of non-fossil sources to ensure faster decarbonisation. The amendment has also broadened the scope for the buildings sector and now includes residential and office buildings, with a minimum connected load of 100 kW. The amendment has changed Energy Conservation Building Code (ECBC) to "Energy Conservation and Sustainable Building Code", which specifies norms and standards for energy efficiency, use of renewable energy and other sustainability-related requirements for different types of buildings.
UJALA Scheme (UNNAT Jyoti by Affordable LEDs for All)	Energy Efficiency Services Limited (EESL), Ministry of Power	Unnat Jyoti by Affordable LEDs for All (UJALA) was launched on January 5, 2015.The main objective of scheme is to promote efficient lighting, enhance awareness on using efficient equipment which reduce electricity bills and preserve environment. Under this scheme, LED Bulbs were distributed. » The programme has quickly evolved to be world's largest zero subsidy domestic lighting programme that addresses concerns like high electrification cost and high emissions that result from inefficient lighting. With UJALA, the cost of LED bulb has come down by 85%. » UJALA has been readily adopted by all the states. It has helped in reducing annual household electricity bills.
Saubhagya Scheme	Ministry of Power	Pradhan Mantri (Sahaj Bijli Har Ghar Yojana) – Saubhagya Scheme was launched by Government of India in October, 2017 with the objective of achieving universal household electrification and to provide electricity connections to all willing un-electrified households in rural areas and urban areas by March, 2019. The electricity connection to households included the release of electricity connections by drawing a service cable from the nearest pole to the household premise, installation of an energy meter, wiring for a single light point with LED bulb, and a mobile charging point. 2.86 crore households have been electrified since the launch of SAUBHAGYA till March 2023 (PIB, 2023).

Table III: Key Policies on Energy in India

Policy/Scheme	Implementation Agency	About Policy/Scheme
Pradhan Mantri UJWALA Yojna	Ministry of Petroleum and Natural Gas	Pradhan Mantri Ujjwala Yojana (PMUY) was launched on 01.05.2016 to release deposit free LPG connection in the name of adult woman member of poor households across the country. The target to release 8 crore connections under PMUY Phase-I was achieved in September, 2019. To cover the remaining poor households, PMUY phase-2 (Ujjwala 2.0) was launched in August 2021 with a target to release 1 crore additional PMUY connections, which was achieved in January 2022. Subsequently, the Government decided to release 60 lakh more LPG connections under Ujjwala 2.0 and as on 01.01.2023, the target of 1.60 crore Ujjwala 2.0 connections has already been achieved. Further, Government has taken several other steps to ensure that all households in the country have access to clean cooking fuels, which include hassle free connections, 5 kg cylinders, secondary connections for an existing domestic LPG consumer, option to apply online for new connection including PMUY and release of e-subscription vouchers, organizing LPG panchayats and public awareness campaigns involving State/UT Governments, etc.
National policy on Biofuels (2022 Amendment)	Ministry of Petroleum and Natural Gas	Government has amended the National Policy on Biofuels – 2018 which has advanced the target of 20% blending of ethanol in petrol to ESY 2025-26 from 2030. The salient features of the National Policy on Bio-fuel-2018 as amended on 15th June, 2022 are as under: » Categorization of biofuels as “Basic Biofuels” and “Advanced Biofuels”; » Incentives, off-take assurance and viability gap funding for advanced biofuels; » Allowing multiple feed-stocks for production of biofuels; » Setting up of supply chain mechanisms for biodiesel production from nonedible oilseeds, Used Cooking Oil, short gestation crops; » Synergy of efforts by defining roles and responsibilities of all the concerned Ministries/Departments with respect to biofuels; » Advancing the ethanol blending target of 20% blending of ethanol in petrol to Ethanol Supply Year (ESY) 2025-26;

Table III: Key Policies on Energy in India

Policy/Scheme	Implementation Agency	About Policy/Scheme
National policy on Biofuels (2022 Amendment) 	Ministry of Petroleum and Natural Gas	» Promotion of the production of biofuels in the country, under the Make in India program, by units located in Special Economic Zones (SEZ)/Export Oriented Units (EoUs); and » Grant of permission for export of biofuels in specific cases. Public Sector Oil Marketing Companies (OMCs) have achieved over 10% ethanol blending in petrol during Ethanol Supply Year (ESY) 2021-22. In March, 2019, Government had notified the "Pradhan Mantri JI-VAN (Jaiv Indhan - Vatavaran Anukool fasalawashesh Nivaran) Yojana" for providing financial support to integrated bio-ethanol projects for setting up Second Generation (2G) ethanol projects in the country using lignocellulosic biomass and other renewable feedstock. The total financial outlay for the scheme is Rs. 1969.50 crore for the period 2018-19 to 2023-24. Since the commencement of PM JI-VAN Yojana, financial assistance of Rs. 895 crores has been approved for six commercial 2G projects being set up by Indian Oil Corporation Ltd. in Haryana, by Hindustan Petroleum Corporation Ltd. in Punjab, by Bharat Petroleum Corporation Ltd. in Odisha, by Numaligarh Refinery Limited in Assam, by Mangalore Refinery and Petrochemicals Ltd in Karnataka, by Shell India Market Pvt. Ltd in Karnataka and three demonstration projects being set up by Indian Oil Corporation Ltd. in Haryana, by Hindustan Petroleum Corporation Ltd in Bihar and by Chempolis India Pvt Ltd in Punjab.
SATAT Scheme (Sustainable Alternative towards Affordable Transportation) 	Ministry of Petroleum and Natural Gas	Sustainable Alternative Towards Affordable Transportation (SATAT) initiative launched in October, 2018 with the aim to establish an ecosystem for production of CBG from various waste/ biomass sources in the country. As on 31st March 2023 Oil and Gas Marketing Companies participating in SATAT have issued 4089 Letters of Intent (LoI) to entrepreneurs for procurement of CBG produced by them. Further, 46 CBG/biogas plants with installed capacity of around 250 MT per annum have been commissioned by LoI holders. This initiative holds great promise for efficient municipal solid waste management and in tackling the problem of polluted urban air due to farm stubble-burning and carbon emissions. Use of CBG will also help bring down dependency on crude oil imports and in realising the Prime Minister's vision of enhancing farmers' income, rural employment and entrepreneurship. This will also help in achieving the target of Net Zero emission.

Table III: Key Policies on Energy in India

Policy/Scheme	Implementation Agency	About Policy/Scheme
Gobardhan Scheme 	Ministry of Jal Shakti	The Galvanizing Organic Bio-Agro Resources Dhan (GOBAR-DHAN) scheme was launched in 2018 as national priority project under the Swachh Bharat Mission Gramin-Phase 2, by the Department of Drinking Water and Sanitation. The operational guidelines of Phase-2 of Swachh Baharat Mission provide for financial assistance up to Rs.50 lakh per district for the period of 2020-21 to 2024-25 for setting up of cluster/community level biogas plants (PIB, 03 FEB 2023). The scheme aims to augment the income of farmers by converting biodegradable waste into CBG. The initiative aims at attracting entrepreneurs for establishing community based CBG plants in rural areas. SATAT initiative encourages entrepreneurs to set up BioCNG plants, produce & supply BioCNG to Oil Marketing Companies (OMCs) for sale as automotive fuels where as GOBAR-DHAN scheme supports the villages to safely manage their cattle waste, agriculture waste, and organic waste in rural areas. It also helps villages in converting their waste to wealth, improve environmental sanitation and curb vector borne diseases.

Annexure IV: Data of Key Figures

Table IV: Data of Figure 12

2021-22	Values in ktoe
Total Coal	457992.4
Lignite	9508.0
Crude Oil	246986.7
Naptha	16273.1
ATF	5465.6
Diesel	78295.7
Lubes	4282.7
Fuel Oil	15400.5
Bitumen	7212.6
Petcoke	15584.4
Motor Spirit	0.0
Kerosene	1987.6
Paraffin Wax	0.0
Petrol	28747.7
Other Petroleum Products	30351.4
Natural Gas	47758.5
LPG	32594.9
Net Electricity Generation	122410.6

TABLE V: Data of Figure 22

	Agriculture	Industry	Household	Transport	Power Sector	Miscellaneous	Commercial	Total
Diesel	606.8	3433.2		3376.2	472.3	68259.0		76147.4
Furnace Oil	83.8	2060.5		1071.5	237.0	2005.6		5458.3
Low Sulphur Heavy Stock	7.2	207.9			11.3	174.2		400.6
Coal	0.0	138175.6			244275.8	0.0		382451.4
Lignite		1210.2			7509.6			8719.9
Electricity	19009.9	43703.9	28416.5	1260.0			7469.0	105674.8
LPG	31.6	245.2	28394.6	134.5			2131.2	31140.5
Natural Gas	147.7	460.7			9039.5	5815.5		46813.3
Naptha	0.0	13888.0			79.3	203.4		15933.6
Kerosene		71.7				19227.7		1878.7
ATF						1966.2		3956.6
Petcoke								11547.8
Lubes								3933.4
Bitumen						11547.8		7222.9
Petrol				29183.7		127.0		29311.5
Parrafin Wax						7222.9		213.1
Other Petroleum Products	91.0	2268.4	0.0	1071.5	248.3	20950.6		28776.2

Annexure V: Energy Supply and Consumption in Quantity

Table VI: Energy Supply and Consumption in Quantity

Fuel Sub Category	Unit	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Coal Supply	MT	847.0	882.1	962.8	978.4	930.3	278.2
Coal Consumption	MT	302.2	313.0	338.8	329.8	331.6	318.3
Lignite Supply	MT	45.2	46.6	44.3	42.1	37.9	47.5
Lignite Consumption	MT	38.8	38.8	37.7	36.3	32.9	38.8
Naptha Supply	MT	14.0	13.3	14.9	13.4	14.1	14.4
Naptha Consumption	MT	13.2	12.9	14.1	14.3	14.1	14.3
ATF Supply	MT	6.9	7.7	8.3	8.4	3.5	5.1
ATF Consumption	MT	7.0	7.6	8.3	8.0	3.7	5.0
Diesel Supply	MT	76.7	80.1	83.9	83.0	71.2	75.6
Diesel Consumption	MT	76.5	81.6	84.1	83.2	73.6	77.7
Lubes Supply	MT	3.1	3.6	3.4	3.6	3.7	4.3
Lubes Consumption	MT	3.5	3.9	3.7	3.8	4.1	4.6
Bitumen Supply	MT	6.1	6.2	6.7	6.8	7.3	7.7
Bitumen Consumption	MT	5.9	6.1	6.7	6.7	7.5	7.9
Petcoke Supply	MT	27.7	27.0	21.5	25.7	20.3	21.1
Petcoke Consumption	MT	24.0	25.7	21.3	21.7	15.6	15.8
Kerosene Supply	MT	6.0	4.4	4.1	3.0	2.4	1.9
Kerosene Consumption	MT	5.4	3.8	3.5	2.4	1.8	1.5
Petrol Supply	MT	21.7	23.9	25.8	28.1	25.5	27.4
Petrol Consumption	MT	237.6	26.2	28.3	30.0	28.0	30.8

Table VI: Energy Supply and Consumption in Quantity

Fuel Sub Category	Unit	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Other Petroleum Products Supply	MT	21.4	25.4	31.2	30.1	31.2	31.6
Other Petroleum Products consumption	MT	6.6	8.3	11.7	11.4	12.8	12.1
Natural Gas Supply	MMSCM	50650	53310	54490	56670	53600	57250
Natural Gas Consumption	MMSCM	30478	32854	34343	36241	34617	39414
LPG Supply	MT	22.1	23.4	25.6	27.2	28.1	28.8
LPG Consumption	MT	21.6	23.3	24.9	26.3	27.6	28.3
Net Electricity Generation	GWh	1163290	1232502	1307685	1,323,048	1314025	1425036
Electricity Consumption	GWh	1061183	1123427	1209972	1248086	1230208	1296300

Annexure VI: Conversion Factors

Table VII: Indian Coal Conversion Factors (Toe/Metric Tonnes)

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Coal Production	0.45	0.44	0.43	0.43	0.43	0.42
Coal Import	0.56	0.56	0.55	0.55	0.57	0.58
Coal Dispatch-Power Sector	0.44	0.44	0.44	0.44	0.43	0.42
Coal Dispatch-Non- Power Sector	0.55	0.55	0.56	0.57	0.56	0.56

Table VIII: Petroleum Product Conversion Factors (Toe/Metric Tonnes)

Diesel	1.035
Furnace Oil	1.048
Low Sulphur Heavy Stock	1.059
LPG	1.13
Natural Gas	0.83
Naptha	1.13
Kerosene	1.045
ATF	1.07
Petcoke	0.74
Lubes	0.96
Bitumen	0.96
Petrol	1.048
Paraffin Wax	0.96
Other Petroleum Products	0.96

Table IX: Electricity and Natural Gas Conversion Factors (Toe/Unit)

Electricity	Gwh	0.0859
Natural Gas	MMSCM	0.83

Annexure VII: Non Energy use of Energy Products

Energy products are used for both energy use and for non-energy use. The non-energy use of energy products refers to the utilization of energy resources for purposes other than producing power or generating heat. This involves using energy products as raw materials or feedstocks in various industrial processes, manufacturing, and chemical production.

Lubricants, which include motor oil and greases, are used in vehicles, machinery, and various industrial processes. Petroleum coke is used as a chemical catalyst, while special naphthas are used in petroleum-based paints. Other petroleum products include distillate and residual fuel oils used as chemical feedstocks as well as polishes and waxes. Natural gas is used as feedstock to make nitrogenous fertilizers and a range of chemical products including ammonia, hydrogen, and methanol.

Natural gas is an important feedstock in the petrochemical industry. However, as it is used for non-energy purpose it is not included in table 16 and table 17.

The following table presents natural gas consumption in the petrochemical industry from 2016-17 to 2021-22, in MMSCM.

Table X: Natural Gas consumption in the petrochemical industry from 2016-17 to 2021-22, in MMSCM

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Natural Gas	4170	4024	3386	3569	3072	2864

Natural gas is an important feedstock in the fertilizer industry. However, as it is used for non-energy purpose it is not included in Figure 17.

The following table presents natural gas consumption in the fertilizer industry from 2016-17 to 2021-22, in MMSCM.

Table XI: Natural Gas consumption in the fertilizer industry from 2016-17 to 2021-22, in MMSCM

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Natural Gas	15429	14676	14987	16115	17781	18079

F. No. 21/4/2022-EC
Government of India
Ministry of Power
****

Shram Shakti Bhawan, Rafi Marg,
New Delhi, Dated 25th August, 2022

ORDER

Subject: Setting up Energy Data Management Unit (EDMU) in the Bureau of Energy Efficiency under Ministry of Power-reg.

Climate change is one of the most challenging phenomenon being faced by the humanity and India has been at the forefront of addressing this issue. India ratified the Paris Agreement on Climate Change in 2015 under which its member countries have given commitments to keep global average temperatures rise below 2-degree C by the end of century. India in its Nationally Determined Contributions (NDCs) has committed that it will reduce the emission intensity of its GDP by 33% to 35% by 2030 from 2005 level.

2. In the recent Conference of Parties (COP -26) held in Glasgow, UK in 2021, the enhanced ambitions announced by India are as given below:

a. India will meet 50 per cent of its cumulative electric power installed capacity with non- fossil fuel sources by 2030. This will include achieving 500 GW of power capacity from non-fossil sources.

b. By 2030, India will reduce the carbon intensity of its economy to less than 45 per cent from 2005 level. This will be achieved by additional reduction of 1 billion tonne of CO2 emissions from now onwards.

c. By 2070, India will achieve the target of net zero emissions.

3. Energy related emissions comprises almost 76% of the total emissions of the country. To achieve these enhanced targets of reducing carbon intensity of the economy and reduction of over 1 billion tonnes of CO2 emission, it is paramount to develop a monitoring system for assessing impacts of various energy related policies being driven by different line Ministries / Departments.

4. There is a need to understand energy use (at both supply as well as demand side) which would facilitate improved efficiency, greater output at lower cost; provides clear understanding to investors and business; and address climate change through identification of cost-effective actions.

4.1 A need has been felt to designate a government agency for compiling and publishing data regarding the supply and consumption of energy in various sectors of economy.

5. In accordance with the allocation of Business Rules of the Ministry of Power, one of the mandates is to develop "General Policy in the electric power sector and issues relating to energy policy and coordination thereof (Details of short, medium and long-term policies in terms of formulation, acceptance, implementation and review of such policies, cutting across sectors, fuels, regions and intra country and inter country flows)." In addition, the Ministry of Power is also mandated for administrating the provisions of Energy conservation Act and deal with the matters related to Bureau of Energy Efficiency (BEE). As per clause (u) under Section 13 of Energy Conservation Act, the Bureau of Energy Efficiency is mandated to may perform such functions and exercise such powers as may be assigned by the Central Government. In view of the above, Bureau of Energy Efficiency (BEE) is designated to act as Agency for Setting up of Energy Data Management Unit.

6. In view of the above, a dedicated Energy Data Management Unit (EDMU) shall be established in BEE which will be discharging aforementioned functions. The EDMU shall comprise of Sector /Technical Experts having substantial domain knowledge in data management dealing with energy and related sectors. The works already being done by various Ministries and NITI Aayog in this area shall be harmonised with the activities of EDMU to minimise duplication of efforts.

7. All Ministries / Departments of Central Government dealing with energy sector would extend support to BEE in gathering data and appropriate information.

8. To guide and oversee the activities of Energy Data Management Unit (EDMU) at Bureau of Energy Efficiency, a Steering Committee is hereby constituted under the Chairmanship of Secretary (Power), comprising members with representatives (not below the rank of Joint Secretary) to be nominated from each Ministry/ Department/ NITI Aayog as mentioned below:

1. NITI Aayog
2. M/o Coal
3. Ministry of New & Renewable Energy
4. M/o Ports Shipping and Waterways
5. M/o Road Transport and Highways
6. M/o Petroleum and Natural Gas
7. M/o Environment Forest and Climate Change
8. DPIIT, M/o Commerce and Industry
9. M/o Civil Aviation
10. D/o Commerce, M/o Commerce and Industry
11. Ministry of Statistics and Programme Implementation, MoSPI
12. Ministry of Housing and Urban Affairs
13. Central Electricity Authority (CEA)
14. Director General, BEE - Convener

7. The Committee will meet at least once every quarter. The ToR for the committee are at **Annex I**.

8. This issues with the approval of Competent Authority.

(Anoop Singh Bisht)
Deputy Secretary to the Govt. Of India
Tel: 2306-2439

To:

All the Members of the Steering Committee.

Copy for information to:

1. PS to Hon'ble Minister of Power and NRE
2. APS to Hon'ble Minister of State for Power and Heavy Industries.
3. PS to Secretary(Power)
4. Sr. PPS to AS(EC,ET&EV)
5. PPS to CE(EC,ET&EV and OM)
6. PPS to DS(EC,ET&EV and OM)

Terms of Reference for the Steering Committee are as follows-

a. To provide guidance in preparatory activities for setting up the Energy Data Management Unit (EDMU).

b. To finalize the structure, roles and functions of EDMU. This would include composition of resources and approve their roles/ responsibilities.

c. To provide direction on the focus sectors/ fields/ areas on the basis of which the data collection methodologies would be finalized and any need for further analysis.

d. To advise and approve standardization of definitions, terminologies and calculation methodology of all the key parameters in the energy sector in line with international standards so that reporting of data is uniform across all sectors and sources.

e. To guide on the approvals for data sharing from different energy related Ministries which is a key component in the formation of EDMU.

f. To provide the guidance for developing India Energy Dashboards which can be referred to as an authentic energy related data source of Government of India.

g. To develop comprehensive and unified approach for energy statistics and enhance their dissemination to facilitate advancements in energy policy.

h. Any other related matter.

Annexure IX: List of representatives from Line Ministries/Departments involved in various Steering Committee Meetings of EDMU

Ministry of Power
Shri Alok Kumar, Secretary (Power) - Chair
Shri Ajay Tewari, Additional Secretary
Shri Narendra Singh, Chief Engineer
Shri Anoop Singh Bisht, Deputy Secretary
Shri Govind Kumar, Under Secretary
Bureau of Energy Efficiency
Shri. Abhay Bakre, Director General
Shri. Arijit Sengupta, Director
Ms. Deepshikha Wadhwa, Senior Sector Expert (Household)
Shri Abhishek Kumar Yadav, Senior Sector Expert (Biomass)
Ms Anju R. Singh, Sector Expert (Service)
Ms Payal Kumari, Sector Expert (Database)
Shri Rakesh Biswas, Project Engineer
Shri Manish Kumar, Project Engineer
NITI Aayog
Shri Rajnath Ram, Advisor, NITI Aayog
Shri Manoj Kumar Upadhyay, Dy. Advisor, NITI Aayog
Shri Venugopal Mothkoor, Sr.Specialist, NITI Aayog
Shri Swapnil Morande, Sr. Associate
Ministry of Statistics and Programme Implementation
Shri Indradeep Roy Chowdhury, Deputy Director
Central Electricity Authority
Shri. Ghanshyam Prasad
Shri Irfan Ahmad, Chief Engineer

Ministry of Petroleum and Natural Gas
D.K. Ojha, Deputy Director General
Shri Gaurav Katiyal, Deputy Director
Ms. Avinash Kumari, Assistant Director
Shri Kapil Verma, Director
Shri Shyam Lal, SSO
Shri Amit Duhan, Technical Officer
Shri Ramit Kalia, Technical Officer
Petroleum Planning & Analysis Cell (PPAC)
Shri P. Manoj Kumar, Director General
Shri Vijay Kansal, Additional Director
Dr. Pankaj Sharma, Additional Director
Ms. Avantika Garg Tayal, Assistant Director
Ministry of Coal
Shri Ankit Kumar Jain, Assistant Director
Shri Ravinder Dabas, Dy. Manager (Finance)
Shri Hara Kumar Hajong, Economic Adviser
Department of Commerce
Smt. Priya Nair, Director
Shri Yashvir Singh, Energy Advisor
Shri Shobeendra Akkayi, Assistant Director
Department for Promotion of Industry and Internal Trade
Dr. Ashish Kumar, Sr. Consultant
Ministry of New and Renewable Energy
Shri Vijay Bharti, Scientist 'C'
Dr. Arun Kumar Tripathi, Advisor, MNRE
Ms. Priya, Scientist- C
Shri Arun Kumar, Director
Shri Prasad Chaphekar, Deputy Secretary
Ministry of Housing and Urban Affairs
Shri G.S. Dhillon, Director
Shri V.P Singh, Director
Smt Reema Jain, Deputy Director

Directorate General of Civil Aviation
Shri Ekshwaku N. Srivastava, Assistant Director
Ms. Ekta Agrawal, Assistant Director
Ministry of Road Transport & Highways
Shri Mahesh Shingade, SC-B
Shri Tagade N. R Scientist B
Shri K.C. Sharma, Superintending Engineer
Ministry of Ports, Shipping and Waterways (MoPSW)
Shri H.N. Ashwath, Development Adviser
Shri Anil Pruthi, Director
Ministry of Environment, Forest and Climate Change
Shri Anshu Singh, Deputy Director General
Shri R N Pankaj, Scientist D
The Energy & Resources Institute (TERI)
Shri Souvik Bhattacharjya, Senior Fellow and Associate Director
Dr. Vatsala Sharma, Associate Fellow
Ms Khyati Singh, Research Associate